

M632

Precision Resistance Decade

Operation manual

MEATEST



Content

| | |
|--|-----------|
| FIGURES | 4 |
| TABLES | 4 |
| 1. BASIC INFORMATION..... | 5 |
| 2. PREPARATION FOR USE | 5 |
| 2.1. INSPECTING PACKAGE CONTENTS, SELECTING THE INSTALLATION LOCATION | 5 |
| 2.2. POWER ON..... | 5 |
| 2.3. WARM-UP TIME..... | 6 |
| 2.4. SAFETY PRECAUTIONS..... | 6 |
| 3. DESCRIPTION..... | 7 |
| 3.1. FRONT PANEL | 7 |
| 3.2. REAR PANEL..... | 9 |
| 4. OPERATION | 10 |
| 4.1. CONNECTION AND DISCONNECTION OF OUTPUT TERMINALS | 10 |
| 4.2. WIRES CONNECTION..... | 10 |
| 4.3. SETTING THE FUNCTION..... | 10 |
| 4.4. SETTING THE VALUE OF OUTPUT SIGNAL..... | 17 |
| 4.5. SETUP MENU..... | 18 |
| 4.6. CALIBRATION MODE..... | 20 |
| 5. PERFORMANCE VERIFICATION TEST | 23 |
| 6. REMOTE CONTROL..... | 24 |
| 6.1. RS232 INTERFACE | 24 |
| 6.2. GPIB INTERFACE (OPTION) | 25 |
| 6.3. LAN INTERFACE (OPTION) | 26 |
| 6.4. USB INTERFACE (OPTION)..... | 27 |
| 6.5. COMMAND SYNTAX..... | 28 |
| 6.6. SCPI COMMAND TREE..... | 29 |
| 6.7. STANDARD STATUS DATA STRUCTURES | 31 |
| 6.8. SCPI STANDARD COMMANDS | 33 |
| 6.9. SCPI COMMANDS | 37 |
| 6.10. SCPI ERROR CODES | 59 |
| 6.11. COMPATIBLE COMMANDS | 60 |
| 6.12. DEMO PROGRAM | 62 |
| 7. MAINTENANCE..... | 63 |
| 7.1. FUSE REPLACING | 63 |
| 7.2. EXTERNAL SURFACE CLEANING..... | 63 |
| 8. MODULE 19" (VERSION M632-VXX1X) | 63 |
| 9. TECHNICAL DATA | 64 |
| ORDERING INFORMATION – OPTIONS..... | 66 |

Figures

| | |
|--|----|
| Figure 1 Starting Screen..... | 6 |
| Figure 2 Front panel | 7 |
| Figure 3 Display | 7 |
| Figure 4 Rear panel | 9 |
| Figure 5 Resistance screen | 10 |
| Figure 6 Platinum screen..... | 11 |
| Figure 7 Nickel screen | 11 |
| Figure 8 User function screen | 12 |
| Figure 9 User function list | 12 |
| Figure 10 New user function..... | 13 |
| Figure 11 User function point editing | 13 |
| Figure 12 User function edit | 14 |
| Figure 13 Timing screen | 14 |
| Figure 14 Time sequence list | 15 |
| Figure 15 New sequence | 15 |
| Figure 16 Timing sequence point editing..... | 16 |
| Figure 17 Timing sequence edit..... | 16 |
| Figure 18 Numeric value entry..... | 17 |
| Figure 19 Setup menu | 18 |
| Figure 20 Password entry | 20 |
| Figure 21 Calibration point screen..... | 22 |
| Figure 22 RS232 9 pin D-SUB MALE connector | 24 |
| Figure 23 IEEE488 connector | 25 |
| Figure 24 LAN connection 1..... | 26 |
| Figure 25 LAN connection 2..... | 26 |
| Figure 26 USB connector..... | 27 |
| Figure 27 Status register overview..... | 31 |
| Figure 28 Module 19" rack, front panel | 63 |

Tables

| | |
|--|----|
| Table 1 M632 Calibration points | 21 |
| Table 2 Verification - allowed deviations..... | 23 |
| Table 3 RS232 cable connection..... | 25 |
| Table 4 OUTPut command structure | 40 |
| Table 5 Keyboard codes..... | 56 |
| Table 6 SCPI error codes | 59 |
| Table 7 M632 Resistance accuracy | 65 |
| Table 8 M632 Pt simulation accuracy..... | 65 |
| Table 9 M632 Ni simulation accuracy | 65 |
| Table 10 M632 Frequency response | 65 |

1. Basic information

Programmable resistance decade M632 is suitable for automated simulation of different resistance sensors (temperature, pressure, position, force ...). Internal design eliminates “zero resistance effect” which is typical for most resistance decades.

Resistance value is created via appropriate combination of physical resistors. Decade is equipped with built-in function of direct simulation of most frequent temperature Pt and Ni sensors. Low thermal voltage relays and stable resistors are used as main parts of the decade. Actual set values are displayed high resolution TFT display. M632 is sophisticated instrument with its own re-calibration procedure. The procedure enables to correct any deviation in resistance without any mechanical adjusting.

Instrument is especially suitable for automatic testing procedures. RS232 line (optionally IEEE488, USB and Ethernet bus) is used for connecting decade to the computer.

2. Preparation for use

2.1. *Inspecting package contents, selecting the installation location*

Basic package includes the following items:

- Resistance decade M632
- RS232 cable
- CD with demo program
- User's manual
- Test report

The instrument must be powered by 230/115 V – 50/60 Hz mains. Before powering on the instruments, place it on a level surface. If the instrument was stored out of range of reference temperatures, let it stabilize for one hour.

2.2. *Power on*

- Before connecting the instrument to the mains, check the position of the mains voltage selector located at the rear panel.
- Plug one end of the power cord into the connector located at the rear panel and connect the other end of the power cord into a wall outlet.

- Switch on the mains switch located at the rear panel. Display is lit.

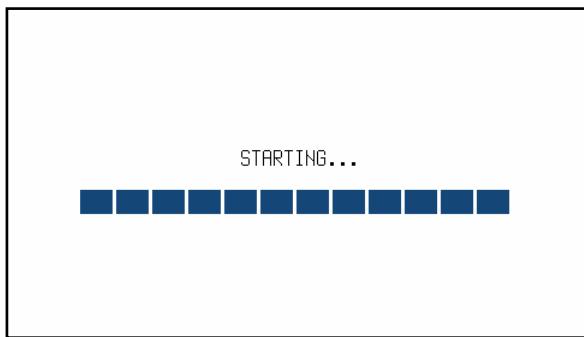


Figure 1 Starting Screen

- The instrument performs internal hardware checks for app. 5 seconds.
- After the tests conclude, the instrument resets to its reference state, i.e. the following parameters are set:

| | |
|------------------|-----------------|
| Function | Resistance |
| Set value | 100.00 Ω |
| Output terminals | OFF |

2.3. Warm-up time

The instrument works after it is switched on and the initial checks complete. Specified parameters are only guaranteed after the instrument warms up for 10 minutes.

2.4. Safety precautions

The instrument has been designed according to EN 61010-1:2011. Safety is ensured by the design and by the use of specific component types.

The manufacturer is not liable for the damage caused by modification of the construction or replacement of parts with non-original ones.

Safety symbols used on the equipment



Warning, reference to the documentation

3. Description

3.1. Front panel

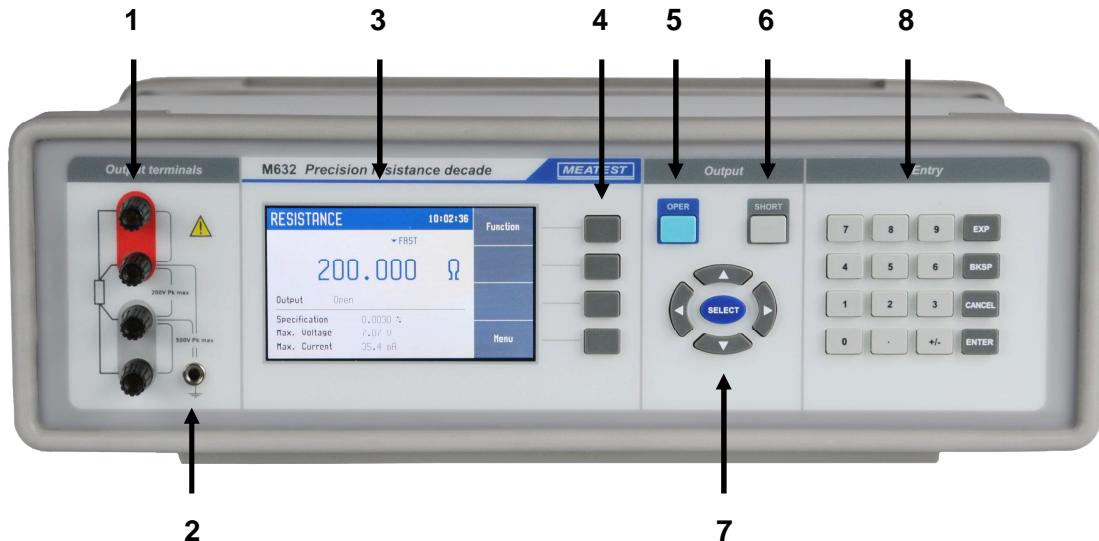


Figure 2 Front panel

On the front panel there are located all main control keys, display and output terminals.

1 Output terminals

Four wire output terminals. Measuring (evaluation) circuit can be connected by 2, 3 or 4 wires. Both sides (red and grey) are floating up to 500Vpk against the case (PE).

2 Ground terminal

Central ground terminal (protective earth) connected to the metal case of the instrument. It is recommended to connect it to the “grey” output terminals if connected meter is not grounded.

3 Display

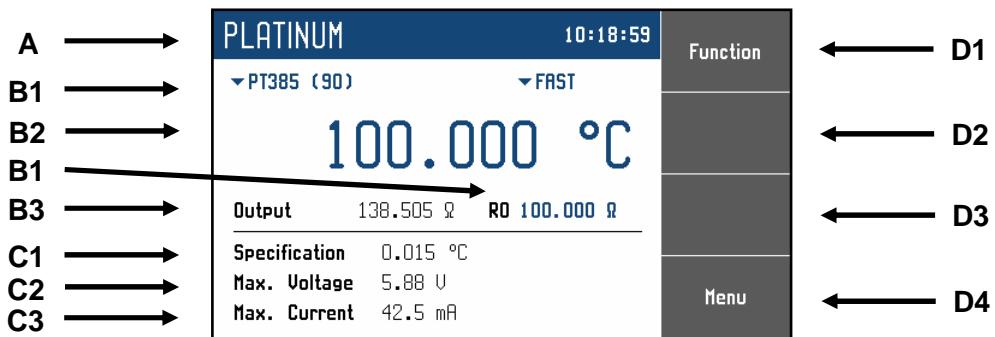


Figure 3 Display

The display is divided into four sections:

A. Information line

- Selected function (RESISTANCE, PLATINUM, ...)
- Time

B. Main area

This section displays the set-up values of generated signals and the data related to the decade box status. The section includes the following types of data:

1. Auxiliary parameters

This section displays auxiliary parameters of actually selected function:

- Temperature standard (PT385, PT3916, ...)
- Switching mode (FAST, VIA OPEN, ...)
- R0 resistance

2. Main value

There is displayed main value of selected function with the unit. There is displayed also actual position of cursor $\blacktriangledown \blacktriangle$ if the parameter is in edit mode. Position of cursor can be changed using keys $\blacktriangleleft, \blacktriangleright$ and parameter can be changed using keys $\blacktriangle, \blacktriangledown$.

3. Output state

There is displayed resistance value connected to the output terminals.

C. Specification

This section displays specification and limits relating to the main value:

1. Specification

This section displays specification of the main value.

2. Maximum voltage

This section displays maximum allowed voltage for the main value.

3. Maximum current

This section displays maximum allowed current for the main value.

D. Softkey labels

The functions of these keys change during operation (depends on selected function and actual display mode).

4 Softkeys

There are four keys next to the display with variable function. The functions of these keys change during operation (depends on selected function and actual display mode).

5 OPER (Operate key)

OPER key connects / disconnects selected value to the output terminals. Connected output terminals are indicated by the lit LED in the key.

6 SHORT (Short key)

Active SHORT key (LED in the key is ON) replaces the main value with the short circuit. Also the short circuit must be connected to the output terminals by the OPER key.

7 Cursor keys

Using these keys, the cursor can be controlled within allowed limits on the display. The keyboard includes two buttons (\blacktriangleleft , \blacktriangleright) which allow the cursor to be set to the required position at the display. The cursor can be moved to the left or right. Numeric values can be set in some control modes as well. In these cases, the buttons marked (\blacktriangleup , \blacktriangledown) allow the user to increase or decrease the number at the cursor position.

The central SELECT key is used to select value you want to change (like TAB key).

8 Numeric keyboard

The keyboard allows the entry of numeric values on the display. ENTER button is used to confirm the selection. CANCEL button can be used to cancel the entry.

Colors on display

Common rules are used for applied color of labels and values.

- Red color is applied, when displayed value is measured by the instrument. This color isn't use in all versions.
- Blue color is applied for parameters or values, which can be set-up or modified directly from front panel keyboard or via Main menu.
- Black color is used for fix values, labels, notes, parameters which cannot be modified and for other fix text with general information purpose.
- Meaning of softkeys is shown in the right part of display. If there is no description next to the softkey, the softkey is not active in selected function.

3.2. Rear panel

There are located power cord socket, power line fuse, power line voltage selector 115/230V, interface connectors RS232 and optionally LAN, USB and IEEE488 on the rear panel.



Figure 4 Rear panel

4. Operation

4.1. Connection and disconnection of output terminals

Set value is connected (disconnected) to the output terminals after pressing OPER key. Connected output terminals are indicated by the lit LED in the key.

Disconnected output terminals can be used for “Open terminals” simulation. “Short circuit” is simulated after pressing SHORT key. Active SHORT key (LED in the key is ON) replaces the main value with the short circuit. Also the short circuit must be connected to the output terminals by the OPER key.

4.2. Wires connection

Output resistance is available on R output terminals. Available is 2, 3 and 4-wire connection. Both sides (red and grey) are floating up to 500Vpk against the case (PE).

Ground terminal is connected to the metal case and to the protective earth (PE).

4.3. Setting the function

Function can be changed after pressing „Function“ softkey. New function is selected using cursor keys \blacktriangle , \blacktriangledown or display softkeys. Selection must be confirmed by pressing SELECT key or „OK“ softkey.

Device supports following functions:

Resistance

Offers direct setting of exact resistance value.

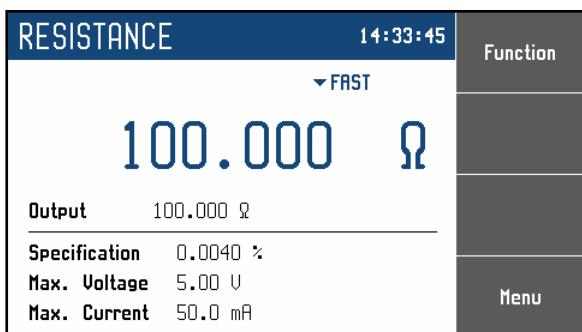


Figure 5 Resistance screen

Editable parameters:

Resistance value: $1 \Omega \dots 1.2 M\Omega$

Switching mode: FAST, SMOOTH, VIA OPEN, VIA SHORT

Platinum

Offers direct setting of temperature of simulated platinum thermometer.

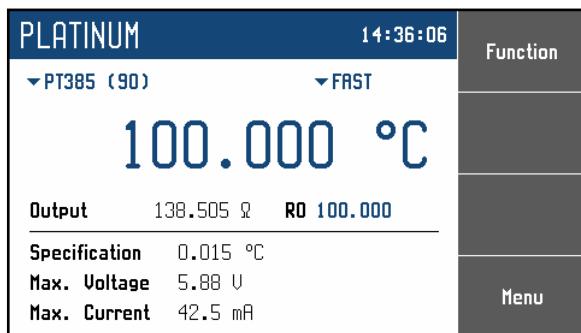


Figure 6 Platinum screen

Editable parameters:

Temperature: -200 °C ... +850 °C (-328 °F ... 1562 °F)
 R0 value: 10 Ω ... 20 kΩ
 Temperature standard: PT385 (68), PT385 (90), PT3916, PT3926, PT User
 Switching mode: FAST, SMOOTH, VIA OPEN, VIA SHORT

Nickel

Offers direct setting of temperature of simulated nickel thermometer.



Figure 7 Nickel screen

Editable parameters:

Temperature: -60 °C ... +300 °C (-76 °F ... 572 °F)
 R0 value: 10 Ω ... 20 kΩ
 Switching mode: FAST, SMOOTH, VIA OPEN, VIA SHORT

User function

Offers simulation of conversion curve defined by a table. User can define more conversion curves. Values between defined points are linearly interpolated.

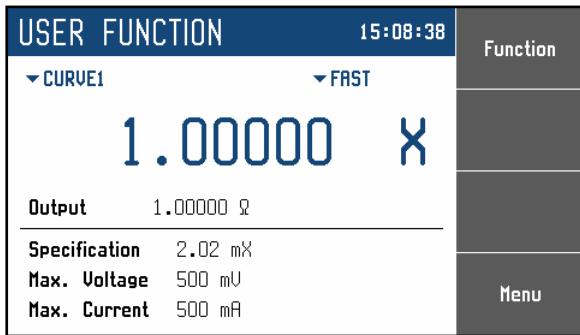


Figure 8 User function screen

Editable parameters:

Main value: according to the function
 User function: curves defined by the user
 Switching mode: FAST, SMOOTH, VIA OPEN, VIA SHORT

Function is defined by table of user values and corresponding resistance values. This table is called „Curve“ and is editable. Maximum number of tables is 10 with each table having up to 8 values but the fewer tables are defined the more values within can be set. For instance one table can have up to 120 values, 3 tables can have up to 36 values and so on. Tables can be defined via remote control as well. Manual table setup can be done in *Menu → Device → User function curve*:

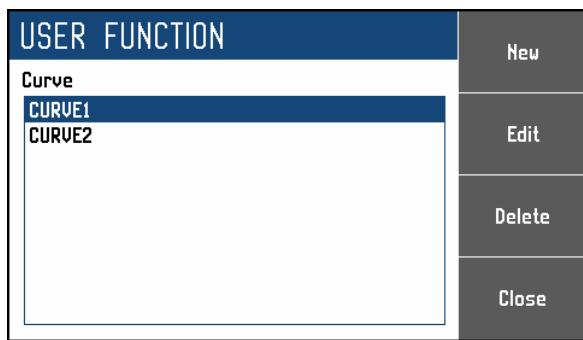


Figure 9 User function list

Menu shows a list of all previously defined tables (curves). Screen above shows two tables named „CURVE1“ and „CURVE2“ but number of tables and their names can be different due to local settings. Softkeys on the right hand side of the panel have these functions:

New – create a plain table (curve).

Edit – edit selected table. Table can be selected using \blacktriangle , \blacktriangledown cursor keys.

Delete – delete selected table.

Close – close the menu and return to *Menu → Device*.

Creating a new table

Pressing the *New* softkey opens this submenu:

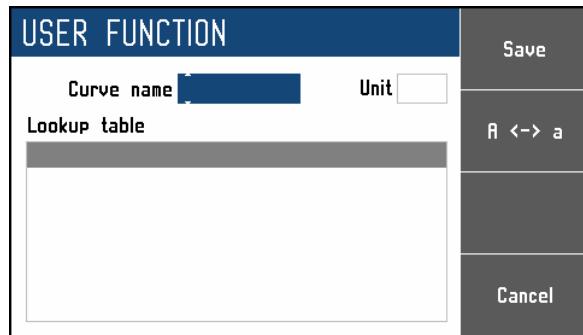


Figure 10 New user function

Curve name – table name is set using $\blacktriangle, \blacktriangledown$ (character selection) and $\blacktriangleleft, \blacktriangleright$ (position) cursor keys. Name may be 8 characters long at most. Softkey „ $A <-> a$ “ switches between uppercase and lowercase of selected character. Table name has to be set before proceeding to the next step using **SELECT** key.

Unit – user function unit abbreviation is set in the same way as table name only it can be just up to two characters long. Unit abbreviation has to be set before proceeding to the next step using the **SELECT** key.

Lookup table – a place where you define user function using values in Ω . Table must contain at least two “user function value $\rightarrow \Omega$ value” points so that a slope of the function can be calculated. Range in user function mode is given by actual resistance range of the decade. Browsing through the table is done by $\blacktriangle, \blacktriangledown$ cursor keys. Editing is done using these contextual softkeys:

Add – create a new point.

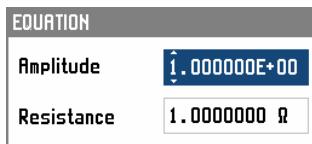


Figure 11 User function point editing

Amplitude – user function value in user units. Press the **SELECT** key to proceed.

Resistance – corresponding Ω value. Range is restricted to actual resistance range of the decade.

Edit – edit selected point.

Delete – delete selected point.

Save – closes the table and saves current settings.

Cancel – closes the table and does not save current settings.

Editing an existing table

Existing table can be edited in the same way as it can be created. Editable entries (Curve name, Unit, Lookup table points) are selected using the **SELECT** key.

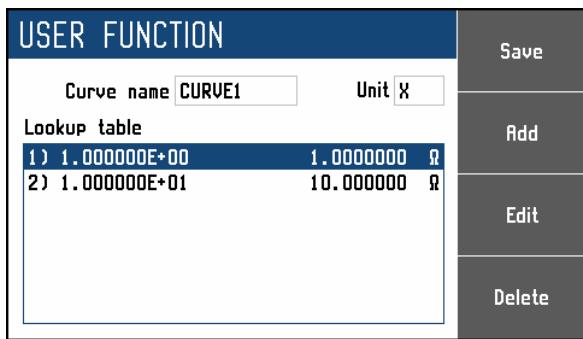


Figure 12 User function edit

Timing

Offers simulation of time-varying resistance defined by a table. User can define more time curves.

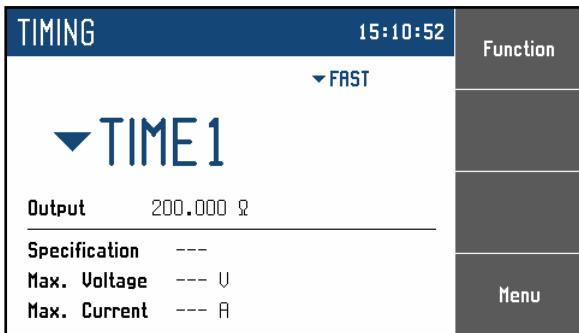


Figure 13 Timing screen

Editable parameters:

Timing table: table defined by the user
 Switching mode: FAST, SMOOTH, VIA OPEN, VIA SHORT

Sequence is defined by table of time intervals and corresponding resistance values. This table is called „Preset“ and is editable. Maximum number of tables is 10 with each table having up to 4 time intervals but the fewer tables are defined the more time intervals within can be set. For instance one table can have up to 60 intervals, 3 tables can have up to 18 intervals and so on. Tables can be defined via remote control as well. Manual table setup can be done in *Menu → Device → Timings*:

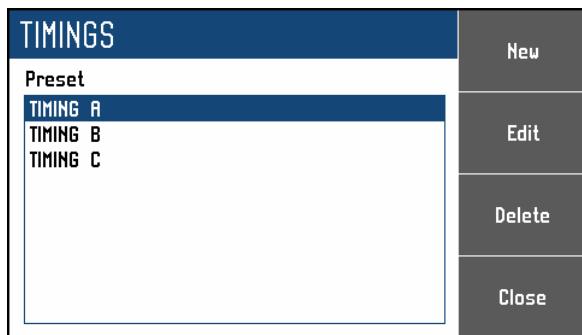


Figure 14 Time sequence list

Menu shows a list of all previously defined tables (presets). Screen above shows three tables named „TIMING A“, „TIMING B“ a „TIMING C“ but number of tables and their names can be different due to local settings. Softkeys on the right hand side of the panel have these functions:

New – create a plain table (Preset).

Edit – edit selected table. Table can be selected using \blacktriangle , \blacktriangledown cursor keys.

Delete – delete selected table.

Close – close the menu and return to *Menu → Device*.

Creating a new table

Pressing the *New* softkey opens this submenu:

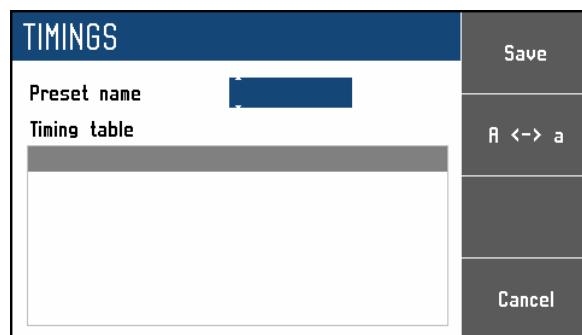


Figure 15 New sequence

Preset name – table name is set using $\blacktriangle, \blacktriangledown$ (character selection) and $\blacktriangleleft, \blacktriangleright$ (position) cursor keys. Name may be 8 characters long at most. Softkey „A $\leftrightarrow a$ “ switches between uppercase and lowercase of selected character. Table name has to be set before proceeding to the next step using **SELECT** key.

Timing table – a list of values in Ω and their durations in seconds. Browsing through the table is done by $\blacktriangle, \blacktriangledown$ cursor keys. Editing is done using these contextual softkeys:

Add – create a new point.



Figure 16 Timing sequence point editing

Time – duration of selected resistance (from 2 ms to 60 s).

Amplitude – corresponding Ω value. Range is restricted to actual resistance range of the decade.

Edit – edit selected point.

Delete – delete selected point.

Save – closes the table and saves current settings.

Cancel – closes the table and does not save current settings.

Editing an existing table

Existing table can be edited in the same way as it can be created. Editable entries (Preset name, Timing table points) are selected using the **SELECT** key.

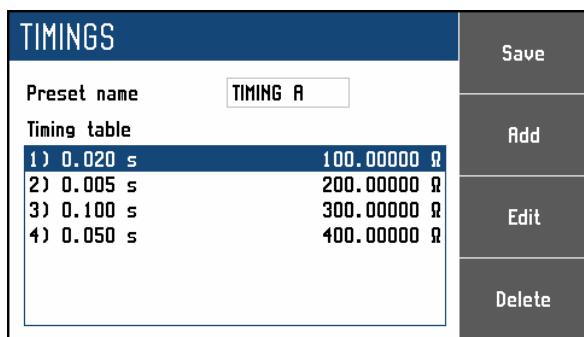


Figure 17 Timing sequence edit

4.4. Setting the value of output signal

Edit mode

Parameters of output signal can be changed in Edit mode. Only parameters displayed in blue color can be changed. Display can be switched to edit mode in different ways:

- Pressing numeric button
- Pressing „Sel“ button (in the middle of cursors buttons)
- Pressing cursor button

In edit mode is edited value highlighted by blue background. Pressing the SELECT button you can change among editable (blue) parameters. Edit mode is finished by pressing CANCEL key.

Entry of the value using numeric keyboard

- Use the numeric keyboard to set the desired value. After the first digit is entered, input box is displayed. In the upper row of the input box is the name of edited parameter. Using softkeys you can enter the new value in different units.



Figure 18 Numeric value entry

- Enter desired value.
- After the entry is complete press softkey with requested unit or press ENTER key. ENTER key inputs the value in basic units (Ω , $^{\circ}\text{C}$, ...).
- Instrument sets the new value.
- The value is copied to the appropriate field in the screen and the input box disappears.

Entry of the value using cursor keys

- Press \blacktriangleleft , \blacktriangleright , \blacktriangleup or \blacktriangledown key. The display now includes cursor marks which points to the active digit.
- \blacktriangleup , \blacktriangledown keys can be used to change the value. \blacktriangleleft , \blacktriangleright keys can be used to change the position of active digit.
- To get to the default screen, press CANCEL key.

Note:

- All parameters have limits (high and low). If the entered value is outside these limits warning message is displayed („Value too high (low)“) and new value is not accepted.

4.5. Setup Menu

Setup Menu is displayed after pressing „Menu“ softkey. Setup menu permits setting device’s parameters. New parameters are saved into the non-volatile memory.

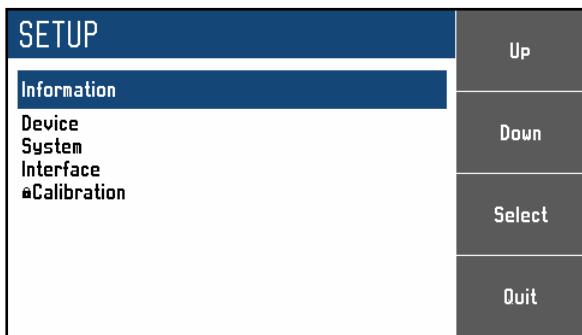


Figure 19 Setup menu

Required menu item is highlighted using cursor keys $\blacktriangle, \blacktriangledown$ or display softkeys. Highlighted menu is selected by pressing SELECT key or „OK“ softkey.

Information

This menu displays information about the device. Items can’t be changed by the user.

Manufacturer

Model

Serial number

Software version

Hardware version

Device

This menu permits setting operational parameters of device.

Temperature unit

Temperature functions can be expressed in different units. Available units are $^{\circ}\text{C}$ (Celsius), $^{\circ}\text{F}$ (Fahrenheit) and K (Kelvin).

Switching

Item defines the way how resistance value is changed. Value R1 is changed to value R2 in the time interval T. Resistance connected to the output terminals can have different values during the time interval T.

FAST Fastest possible switching method.

T is typically 400us.

Resistance during T is undefined. It can be higher or lower than R1 (R2).

SMOOTH Method with smallest possible resistance change.

T is typically 1ms.

Resistance during T can’t be higher than max (R1, R2) and can be lower than min (R1, R2).

VIA OPEN 2 steps switching method. R1 is switched to OPEN and then to R2.

T is typically 1ms.

VIA SHORT 2 steps switching method. R1 is switched to SHORT and than to R2.
 T is typically 1ms.
 SHORT value is lower than min (R1, R2).

Platinum standard

Platinum thermometers can be simulated according to the different standards. Available standards are:

| | |
|------------|--|
| PT385 (68) | DIN, standard EN60751, temperature scale IPTS68 $(A=3.90802e-3, B=-5.80195e-7, C=-4.2735e-12)$ |
| PT385 (90) | DIN, standard EN60751, temperature scale ITS90 $(A=3.9083e-3, B=-5.775e-7, C=-4.18301e-12)$ |
| PT3916 | Pt3916 temperature curve $(A=3.9692e-3, B=-5.8495e-7, C=-4.2325e-12)$ |
| PT3926 | Pt3926 temperature curve $(A=3.9848e-3, B=-5.870e-7, C=-4.0e-12)$ |
| PT User | user defined temperature curve $(A=3.9083e-3, B=-5.775e-7, C=-4.18301e-12)$ – values can be changed |

Platinum user coefficients

This menu permits A, B and C coefficients definition of the PT User platinum standard (see above).

Timings

This menu permits definition of different time dependent resistance curves. Each curve is defined by the Timing table. Each row in the table contains information about resistance value and time for which is this value applied. If the timing function is activated all rows are sequentially executed. User can define more timing tables with different names. Number of rows is limited to 50.

User function curve

This menu permits definition of different conversion curves. Each curve is defined by the Lookup table. Each row in the table contains information about value of simulated function and appropriate resistance value. User can define more lookup tables with different names. Typical application is definition table for simulation of non-standard resistance thermometers. Number of rows is limited to 100.

System

This menu permits setting system parameters of device.

Language

Language setting.

Backlight

Display backlight level setting.

Beeper volume

Beeper volume level setting.

Keyboard beep

Enables / Disables keyboard beep.

Time

Internal time setting.

Date

Internal date setting

Interface

This menu permits setting parameters of remote control interfaces.

Active bus

Active bus setting. Only active bus can be used for remote control.

RS232 Baudrate

RS232 communication baudrate setting. The same baudrate must be used in the controller.

GPIB Address

GPIB address setting. Each instrument connected to the GPIB bus must have a unique address.

LAN Settings

Ethernet parameters setting. Device use Telnet protocol. Default setting is:

| | | |
|-----------------|-----------------|---------------------------|
| DHCP | ON | |
| IP Address | 192.168.001.100 | only valid if DHCP is OFF |
| Subnet mask | 255.255.255.000 | only valid if DHCP is OFF |
| Default gateway | 255.255.255.255 | only valid if DHCP is OFF |
| Port number | 23 | |
| Host name | M632_SN620031 | only valid if DHCP is ON |

4.6. Calibration mode

In this mode resistance elements of the decade can be recalibrated. Access to the calibration mode is from the setup Menu.

Correct password must be entered before calibration. Without correct password the access to the calibration mode is refused. Default factory set calibration code is “2”. Return to standard mode is possible after pushing the key ESC.

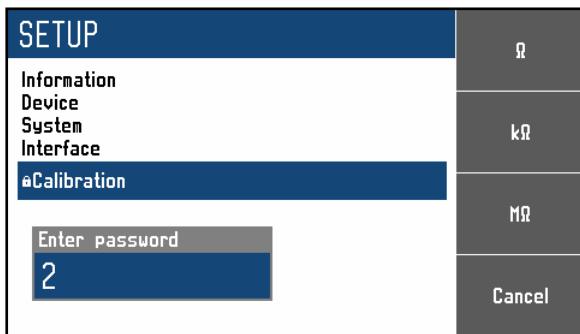


Figure 20 Password entry

Recalibration procedure consists of measuring of 37 basic resistance values and entering their actually measured data. Calibration point can be changes using display softkeys “Previous” and “Next”. Calibration value of selected resistance can be change using cursor keys \blacktriangleleft , \triangleright , \blacktriangleup , \blacktriangledown .

Following table describes nominal values of calibration points and requested recalibration accuracy:

Calibration points M632

| Standard | Nominal value | Requested Accuracy |
|----------|-----------------|--------------------|
| R1 | 1,95 Ω | 1 m Ω |
| R2 | 3,88 Ω | 1 m Ω |
| R3 | 7,73 Ω | 1 m Ω |
| R4 | 15,4 Ω | 1 m Ω |
| R5 | 30,5 Ω | 1 m Ω |
| R6 | 60,4 Ω | 1 m Ω |
| R7 | 120 Ω | 2 m Ω |
| R8 | 237 Ω | 3 m Ω |
| R9 | 464 Ω | 6 m Ω |
| R10 | 909 Ω | 15 m Ω |
| R11 | 1,78 k Ω | 30 m Ω |
| R12 | 3,48 k Ω | 100 m Ω |
| R13 | 6,87 k Ω | 250 m Ω |
| R14 | 13,5 k Ω | 500 m Ω |
| R15 | 26,6 k Ω | 1 Ω |
| R16 | 52,2 k Ω | 5 Ω |
| R17 | 103 k Ω | 10 Ω |
| R18 | 202 k Ω | 20 Ω |
| R19 | 396 k Ω | 40 Ω |
| R20 | 778 k Ω | 80 Ω |
| R21 | 1,54 M Ω | 200 Ω |
| R22 | 3,03 M Ω | 400 Ω |
| R23 | 6,0 M Ω | 1 k Ω |
| R24 | 12 M Ω | 5 k Ω |
| R25 | 23 M Ω | 50 k Ω |
| R26 | 48 M Ω | 200 k Ω |
| R27 | 100 M Ω | 500 k Ω |
| R28 | 200 M Ω | 1 M Ω |
| R29 | 2,09 k Ω | 40 m Ω |
| R30 | 4,14 k Ω | 80 m Ω |
| R31 | 8,18 k Ω | 100 m Ω |
| R32 | 16,1 k Ω | 200 m Ω |
| R33 | 34,3 k Ω | 500 m Ω |
| R34 | 75,3 k Ω | 1 Ω |
| R35 | 150 k Ω | 4 Ω |
| R36 | 301 k Ω | 10 Ω |
| R37 | 602 k Ω | 20 Ω |

Table 1 M632 Calibration points

Process of calibration consists of measuring partial resistances and writing their actual values into the decade:

- Set the first calibration point (resistance element). Use display softkeys “Previous” and “Next” to select the element.
- Measure resistance of the selected element. Use ohm-meter with appropriate accuracy in 4-wire connection mode.

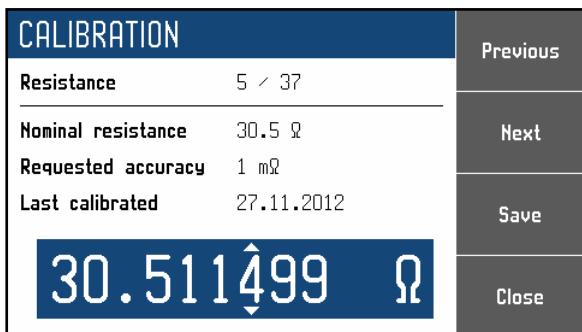


Figure 21 Calibration point screen

- Using cursor keys $\blacktriangle, \blacktriangledown, \blacktriangleleft, \blacktriangleright$ adjust resistance value in M632 according to the ohm meter.
- Confirm new calibration value by pressing “Save” softkey.
- Repeat above described procedure for all resistance elements.

5. Performance verification test

Parameter verification procedure is described in the chapter. Verification procedure is based on measuring resistance on the decade output terminals with standard multimeter in recommended points.

Required equipment

- Ohm-meter nominal accuracy 0.001% in range 1 Ω to 1.2 M Ω (type Fluke 8508A or similar)

Decade setting

Switch decade to the resistance function. Connect standard multimeter to the decade output terminals. Use four-wire connection technique.

Procedure

Use following procedure to perform parameter verification test:

1. Switch both instruments on and let them for 1 hour stabilise in the laboratory with ambient temperature 23 ± 3 °C. Connect resistance decade terminals R4W to the standard ohm-meter (multimeter).
2. Case of decade should be grounded or connected to the Lo terminal of multimeter.
3. Check resistance value in points according to Table I.

Maximal absolute deviations M632

| Nominal value | M632 max. deviation |
|----------------------|----------------------------|
| 1 Ω | 2.0 m Ω |
| 2 Ω | 2.0 m Ω |
| 5 Ω | 2.1 m Ω |
| 10 Ω | 2.2 m Ω |
| 16 Ω | 2.2 m Ω |
| 20 Ω | 2.4 m Ω |
| 50 Ω | 3.0 m Ω |
| 100 Ω | 4.0 m Ω |
| 200 Ω | 6.0 m Ω |
| 500 Ω | 15 m Ω |
| 1 k Ω | 30 m Ω |
| 2 k Ω | 60 m Ω |
| 5 k Ω | 150 m Ω |
| 10 k Ω | 300 m Ω |
| 20 k Ω | 600 m Ω |
| 50 k Ω | 1.5 Ω |
| 100 k Ω | 3.0 Ω |
| 200 k Ω | 6.0 Ω |
| 400 k Ω | 20 Ω |
| 500 k Ω | 25 Ω |
| 1 M Ω | 50 Ω |
| 1.2 M Ω | 60 Ω |

Table 2 Verification - allowed deviations

6. Remote control

Decade box can be controled via RS232, GPIB, LAN and USB interface. The decade can be only controlled by one of interfaces at a time. It is therefore necessary to select and set-up one of the interfaces using the system menu. All interfaces shares the same commands except following commands, which are intended only for use with RS232, LAN and USB interface:

SYSTem:LOCal

This command places decade in the “LOCAL” mode.

SYSTem:REMote

This command places decade in the “REMOTE” mode.

SYSTem:RWLock

This command places the decade in the “REMOTE” mode and locks all keys (including LOCAL key) on front panel.

NOTE: If device is not in REMOTE mode all other commands are ignored by decade (for RS232, LAN and USB interface). With the exception of Compatible commands which are processed each time. GPIB interface places device in the “REMOTE” mode automatically by opening the GPIB interface and therefore these commands are not intended for this interface.

6.1. RS232 Interface

The decade box can be controled via standard RS232 interface.

Following equipment is required:

- M632 decade box
- Personal Computer (or other controlling device) with RS232 port (USB-to-RS232 converter is also possible)
- 9-pin D-SUB, 3-wire direct (1:1) male/female RS232 cable

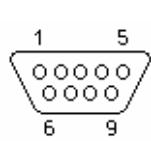
The RS232 interface must be selected from decade system menu to be in operation (*SETUP->Interface->Active bus*). There is only one RS232 setting accessible from the decade system menu under *SETUP->Interface* path:

RS232 Baudrate 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200

Other RS232 parameters are fixed to the following settings:

| | |
|----------------------|------|
| Number of data bits | 8 |
| Number of stop bits | 1 |
| Parity | None |
| Handshake (XON/XOFF) | Off |

RS232 connection



| Pin | Label | I/O | Description |
|-----|-------|--------|-------------|
| 2 | TXD | output | Transmitter |
| 3 | RXD | input | Receiver |
| 5 | GND | - | Ground |

Figure 22 RS232 9 pin D-SUB MALE connector

Cable between decade and computer description (configuration 1:1)

| Computer | D-Sub 1 | D-Sub 2 | M632 |
|-------------|---------|---------|-------------|
| Receiver | 2 | 2 | Transmitter |
| Transmitter | 3 | 3 | Receiver |
| Ground | 5 | 5 | Ground |

Table 3 RS232 cable connection

6.2. *GPIB Interface (option)*

The decade box can be controled via GPIB (General Purpose Interface Bus) interface.

Following equipment is required:

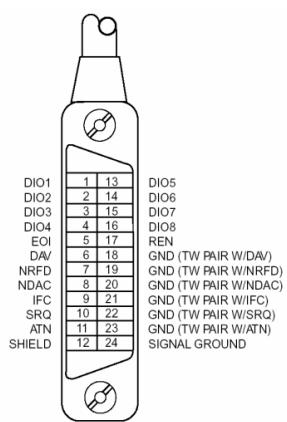
- M632 decade box with LAN, USB, IEEE488 bus option
- Personal Computer (or other controling device) with GPIB interface
- GPIB cable

The GPIB interface must be selected from decade system menu to be in operation (*SETUP->Interface->Active bus*). There is only one GPIB setting accesible from the decade system menu under *SETUP->Interface* path:

GPIB Address 1 to 31

The instrument performs the following functions based on IEEE488 bus commands:

SH1, AH1, T5, L3, RL1, DC1



The instrument also recognizes the following general commands:

DCL Device Clear - resets the instrument to its basic state

SDC Selected Device Clear - resets the instrument to its basic state

GTL Go To Local - switches the remote control off

LLO Local Lock Out - switches the local control off, the instrument cannot be controlled from the front panel

Commands are identical to the commands for RS-232 interface. Detailed description is shown in chapter 8.2.

Figure 23 IEEE488 connector

6.3. LAN Interface (option)

LAN Interface allows communication with decade box using Telnet protocol. A proper setting must be established.

Following equipment is required:

- M632 decade box with LAN, USB, IEEE488 bus option
- Personal Computer (or other controlling device) with LAN interface
- LAN cable

The LAN interface must be selected from decade system menu to be in operation (*SETUP->Interface->Active bus*). There are following LAN settings accessible from decade system menu under *SETUP->Interface->LAN Settings* path (values are default ones):

| | | |
|-----------------|-----------------|---------------------------|
| DHCP | ON | |
| IP Address | 192.168.001.100 | only valid if DHCP is OFF |
| Subnet mask | 255.255.255.000 | only valid if DHCP is OFF |
| Default gateway | 255.255.255.255 | only valid if DHCP is OFF |
| Port number | 23 | |
| Host name | M632_SN620031 | only valid if DHCP is ON |

If DHCP (Dynamic Host Configuration Protocol) is enabled, the IP Address and all necessary settings are done automatically and connection in Telnet protocol is done via “Host name” and “Port number”. Otherwise the IP address, Subnet mask and Default gateway should be properly set. In this case connection is done via “IP Address” and “Port number”.

Connection to decade box using Microsoft Telnet terminal with DHCP option enabled:



Figure 24 LAN connection 1

If connection is successful following screen will appear:



Figure 25 LAN connection 2

6.4. USB Interface (option)

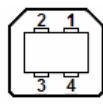
The decade box can be controled via USB (Universal Serial Bus) interface.

Following equipment is required:

- M632 decade box with LAN, USB, IEEE488 bus option
- Personal Computer (or other controling device) with USB interface (USB type A connector)
- Standard USB A-B cable

The USB interface must be selected from decade system menu to be in operation (*SETUP->Interface->Active bus*). There is no USB setting in the decade.

Decade box is equiped with USB type B connector.



| Pin | Label | Description |
|-----|-------|---------------|
| 1 | +5V | Power supply |
| 2 | DATA- | Data signal - |
| 3 | DATA+ | Data signal + |
| 4 | GND | Ground |

Figure 26 USB connector

Communication from user control program is performed via standard RS232 interface. Following settings should be set on your PC for propper operation:

| | |
|-----------|---------|
| Baudrate | 9600 Bd |
| Data bits | 8 |
| Stop bits | 1 |
| Parity | None |

Also proper COM port must be selected. After connecting decade to your PC, virtual COM port should appear in System Control panel of Microsoft Windows OS. This COM port is labeled “USB Serial Port (COMxx)”.

6.5. Command syntax

The commands described in this chapter can be issued through all buses (RS232/GPIB/LAN/USB).

All commands listed in this chapter are explained in two columns:

KEYWORD and PARAMETERS.

KEYWORD column includes the name of the command. Each command includes one or more keywords. If a keyword is in brackets ([]), it is not mandatory. Non-mandatory commands are used only to achieve compatibility with language standard SCPI.

Capitals designate the abbreviated form of the commands; extended form is written in lowercase.

Command parameters are in brackets (<>); each parameter is separated using a comma. Parameters in brackets ([]) are not mandatory. Line (|) means “or” and is used to separate several alternative parameters.

Semicolon ‘;’ is used to separate more commands written on one line.

E.g. :RES 100;:OUTP ON

Terminators:

For GPIB interface each command line must end with <lf>. Response from the device also returns <lf>. For non GPIB interfaces <cr>, <lf> or <crlf> can be used as terminator. The device returns <crlf> in this case. The device performs all commands written on one line of the program after it receives terminator. Without terminator, the program line is not executed.

Description of abbreviations

<DNPD> = Decimal Numeric Program Data, this format is used to express decimal number with or without the exponent.

<CPD> = Character Program Data. Usually, it represents a group of alternative character parameters. E.g. {SERIAL|GPIB|USB|LAN}.

<SPD> = String Program Data (quoted string). This type of parameter is similar to CPD, but allows transmission of more ISO characters.

<BOOL> = Boolean Program Data. This type of parameter has only two states 0 and 1. Parameter can take form of integer value (0 or 1), or character alias (ON or OFF). Device always returns integer value (0 or 1).

<UNIT> = unit parameter works in conjunction with DNPD parameter and specifies unit of DNPD (numeric) value. Unit must be selected from predefined ones. If UNIT part is omitted, default one is used. Query always returns actual unit.

? = A flag indicating a request for the value of the parameter specified by the command. No other parameter than the question mark can be used.

(?) = A flag indicating a request for the parameter specified by the command. This command permits a value to be set as well as requested.

<cr> = carriage return. ASCII code 13. This code executes the program line.

<lf> = line feed. ASCII code 10. This code executes the program line.

6.6. SCPI Command Tree

This chapter summarizes all public SCPI commands supported by device in alphabetic order. Detailed description follows in next chapter.

```

:CALibration
  :RESistance
    :AMPLitude(?) <DNPD>
    :SElect(?) <DNPD>
:SECure
  :PASword(?) <DNPD>
  :EXIT
:DISPlay
  :ANNotation
  :CLOCk
    :DATE
      :FORMAT(?) {MDYS|MDYA|DMYS|DMYO|DMYA|YMDS|YMDO}
      [:STATE](?) {ON|OFF|1|0}
  :BRIGhtness(?) <DNPD>
  :LANGuage(?) {ENGLish|DEUTsch|FRENch|RUSSian|SPANish|CZECh}
:OUTPut
  :SHORt(?) {ON|OFF|1|0}
  [:STATE](?) {ON|OFF|1|0}
  :SWITching(?) {FAST|SMOoth|OPEN|SHORt}
[:SOURce]
  :NICKel
    [:AMPLitude](?) <DNPD>[{CEL|FAR|K}]
    :ZRESistance(?) <DNPD>[OHM]
  :PLATinum
    [:AMPLitude](?) <DNPD>[{CEL|FAR|K}]
    :COEFFcient(?) <DNPD>,<DNPD>,<DNPD>
    :STANdard(?) {PT385A|PT385B|PT3916|PT3926|USER}
    :ZRESistance(?) <DNPD>[OHM]
  :RESistance
    [:AMPLitude](?) <DNPD>[OHM]
  :TIMing
    :PAPPend <SPD>
    :PCount? <DNPD>
    :PRESet<IND_PRESET>
      :NAME(?) <SPD>
      :PDElete
      :RAPPend <SPD>
      :RCount? <DNPD>
      :ROW<IND_ROW>
        :AMPLitude(?) <SPD>
        :RDElete
    :SElect(?) <DNPD>
  :UFUNction
    [:AMPLitude](?) <DNPD>
    :CURVe
      :SElect(?) <DNPD>
      :PAPPend <SPD>
      :PCount? <DNPD>
      :PRESet<IND_PRESET>
        :NAME(?) <SPD>

```

```

:PDElete
:RAPPend <SPD>
:RCOunt? <DNPD>
:ROW<IND_ROW>
    :AMPLitude(?) <SPD>
    :RDElete
    :UNIT(?) <SPD>

:STATus
:OPERation
    :CONDITION(?) <DNPD>
    :ENABLE(?) <DNPD>
    [:EVENT]? <DNPD>
    :NTRansition(?) <DNPD>
    :PTRansition(?) <DNPD>

:QUEstionable
    :CONDITION(?) <DNPD>
    :ENABLE(?) <DNPD>
    [:EVENT]? <DNPD>
    :NTRansition(?) <DNPD>
    :PTRansition(?) <DNPD>

:SYSTem
:BEEPer
    :STATE(?) {ON|OFF|1|0}
    :VOLume(?) <DNPD>
:COMMunicate
    :BUS(?) {SERial|GPIB|USB|LAN}
    :GPIB
        :ADDRess(?) <DNPD>
    :LAN
        :ADDRess(?) <CPD>
        :MASK(?) <CPD>
        :GATE(?) <CPD>
        :PORT(?) <DNPD>
        :HOST(?) <CPD>
        :DHCP(?) {ON|OFF|1|0}
    :REStart
    :SERial
        :BAUD(?) {1200|2400|4800|9600|19200|38400|57600|115200}
:DATE(?) <DNPD>,<DNPD>,<DNPD>
:ERRor
    [:NEXT]? <CPD>
    :KEY(?) <DNPD>
    :LOCal
    :PRESet
    :REMote
    :RWLock
    :TIME(?) <DNPD>,<DNPD>,<DNPD>
    :VERSion? <CPD>

:UNIT
    :TEMPerature(?) {CEL|FAR|K}

*CLS
*ESE(?)  

*ESR?  

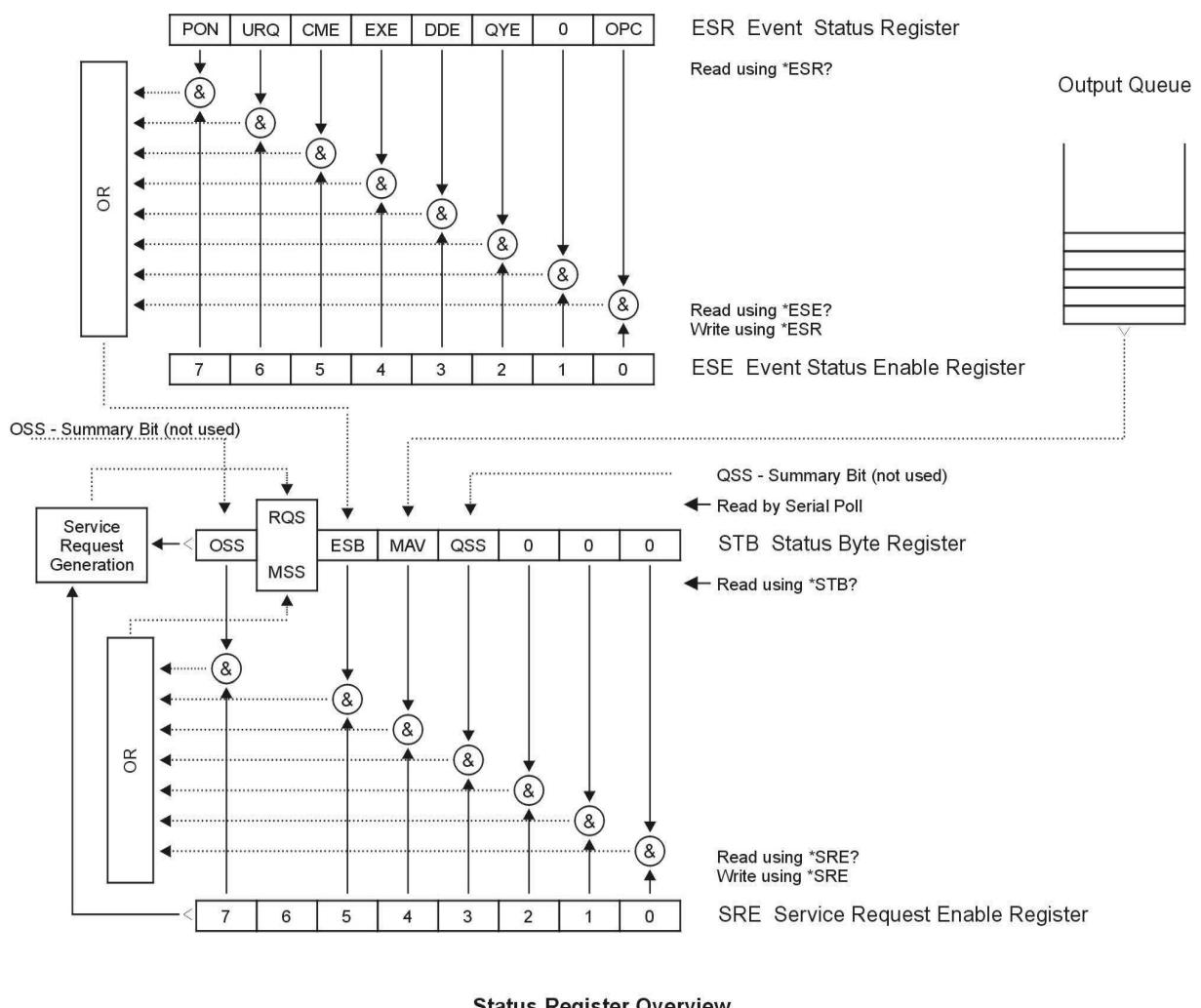
*IDN?  

*OPC(?)
```

*OPT?
 *RST
 *SRE(?)
 *STB?
 *TST?
 *WAI

6.7. Standard Status Data Structures

Decade box meets standard protocol according to the standard IEEE488.2. The protocol can be used for checking of error and status behavior of the device. It enables single-wire transmitting of SRQ command. The conditions on which SRQ signal (local control request) is sent can be set with parameters *STB?, *SRE?, *SRE, *ESR?, *ESE?, *ESE a *CLS.



Status Register Overview

Figure 27 Status register overview

Status data structure contains following registers:

STB – Status Byte Register
 SRE – Service Request Enable Register
 ESR – Event Status Register
 ESE – Event Status Enable Register
 Output Queue

STB Status Byte Register

STB is main register where information from other status registers and from output queue is collected. Value of STB register is reset after switching on the device or after sending command *CLS. This command reset the STB register except bit MAV, which remains set if the output queue is not empty. STB register value can be read via serial message or through general query *STB?.

Bit configuration of Status Byte Register:

- OSS Operation Summary Status, bit 7. SCPI-defined. The OSS bit is set to 1 when the data in the OSR (Operation Status Register) contains one or more enabled bits which are true.
- RQS Request Service, bit 6. The bit is read as a part of status byte only when serial message is sent.
- MSS Master Summary Status, bit 6. The MSS bit is set to 1 whenever bits ESB or MAV are 1 and enabled (1) in the SRE. This bit can be read using the *STB? command. Its value is derived from STB and SRE status.
- ESB Event Summary Bit, bit 5. His value is derived from STB and SRE status. The ESB bit is set to 1 when one or more enabled ESR bits are set to 1.
- MAV Message Available, bit 4. The MAV bit is set to 1 whenever data is available in the IEEE488 Output Queue (the response on query is ready).
- QSS Questionable Summary Status, bit 3. SCPI-defined. The QSS bit is set to 1 when the data in the QSR (Questionable Status Register) contains one or more enabled bits which are true.

SRE Service Request Enable Register

The Service Request Enable Register suppresses or allows the STB bits. “0” value of a SRE bit means, that the bit does not influence value of MSS bit. Value of any unmasked STB bit results in setting of the MSS bit to the level “1”. SRE bit 6 is not influenced and its value is “0”. The SRE register value can be set via the command *SRE followed by mask register value (0 – 191). The register can be read with the command *SRE?. The register is automatically resets after switching the decade box on. The register is not reset by the command *CLS.

ESR Event Status Register

Every bit of the EventStatusRegister corresponds to one event. Bit is set when the event is changed and it remains set also when the event passed. The ESR is cleared when the power is turned on (except bit PON which is set), and every time it is read via command *ESR? Or cleared with *CLS.

Bit configuration of Event Status Register:

- PON Power On, bit 7. This event bit indicates that an off-to-on transition has occurred in the device’s power supply.
- URQ User Request, bit 6. Bit is not used and it is always “0”.
- CME Command Error, bit 5. This event bit indicates that an incorrectly formed command or query has been detected by the instrument.
- EXE Execution Error, bit 4. This event bit indicates that the received command cannot be executed, owing to the device state or the command parameter being out of limits.
- DDE Device Dependent Error, bit 3. This event bit indicates that an error has occurred which is neither a Command Error, a Query Error, nor an Execution Error. A Device-specific Error is any executed device operation that did not properly complete due to some condition, such as overload.
- QYE Query Error, bit 2. The bit is set if the decade box is addressed as talker and output queue is empty or if control unit did not pick up response before sending next query.
- OPC Operation Complete, bit 0. This event bit is generated in response to the *OPC command. It indicates that the device has completed all selected pending operations.

ESE Event Status Enable Register

The Event Status Enable Register allows one or more events in the Event Status Register to be reflected in the ESB summary-message bit. This register is defined for 8 bits, each corresponding to

the bits in the Event Status Register. The Event Status Enable Register is read with the common query *ESE?. Data is returned as a binary-weighted value. The Event Status Enable Register is written to by the common command, *ESE. Sending the *ESE common command followed by a zero clears the ESE. The Event Status Enable Register is cleared upon power-on.

It suppresses or allows bits in ESR register. Value „0“ of a bit of ESE register suppresses influence of appropriate bit of ESR register on value of sum bit of ESB status register. Setting of any unmask bit of ESR register results in setting of ESB status register. ESE register value can be modified by command *ESE followed by value of mask register (integer in range 0 –255). Reading of the register can be performed with command *ESE?. The register is automatically reset after switching on. The register is not reset with *CLS command.

Operation Status Register

Not used in the decade box.

Questionable Status Register

Not used in the decade box.

Output Queue

The Output Queue stores response messages until they are read from control unit. If there is at minimum one sign in the output queue, MAV register (message available) is set. The Output Queue is cleared upon power-on and after reading all signs from output queue.

Error Queue

The Error Queue stores error messages. They are placed in a “first in, first out” queue.

The queue is read destructively using the query command “SYSTem:ERRor?” to obtain a code number and erro message. The query “SYSTem:ERRor?” can be used to read errors in the queue until it is empty, when the message “0, No Error” will be returned.

6.8. SCPI Standard Commands

This chapter describes standard SCPI commands.

***IDN?**

Syntax:

*IDN?

Description:

This command returns the identification of the manufacturer, model, serial number and firmware revision.

Parameters:

<CPD> manufacturer

<CPD> model

<DNPD> serial number

<DNPD> firmware version

Remarks:

Overlapped command

Example:

*IDN? Response: MEATEST,M632,620151,1.00

***OPC**

Syntax:

*OPC

Description:

This command sets the OPC bit in the ESR (Event Status Register) when all pending operations are complete.

Parameters:

None

Remarks:

Overlapped command

Example:

*OPC

***OPC?**

Syntax:

*OPC?

Description:

This command returns “1” to the output queue after all pending operations inside decade box are complete.

Parameters:

<DNPD> always returns 1

Remarks:

Sequential command

Example:

*OPC? Response: 1

***OPT?**

Syntax:

*OPT?

Description:

This command return the instrument's hardware fitment. The only parameter returns presence of GPIB/LAN/USB interface.

Parameters:

<DNPD> 0 – extended interface not present, 1 – extended interface present

Remarks:

Overlapped command

Example:

*OPT? Response: 1

***WAI**

Syntax:

*WAI

Description:

Prevents the instrument from executing any further commands or queries until all previous remote commands have been executed.

Parameters:

None

Remarks:

Sequential command

Example:

*WAI

***RST**

Syntax:

*RST

Description:

This command resets the device to its initial status.

Parameters:

None

Remarks:

Sequential command

Example:

*RST

***TST?**

Syntax:

*TST?

Description:

This command launches internal self-test and returns result.

Parameters:

<DNPD> 0 – test passed, 1 – test failed

Remarks:

Sequential command

Example:

*TST? Response: 0

***STB?**

Syntax:

*STB?

Description:

This query returns content of register STB, which carries the MSS bit status.

Parameters:

<DNPD> Status byte register, Range 0 ... 255

Remarks:

Overlapped command

Example:

*STB? Response: 0

***SRE**

Syntax:

*SRE

*SRE?

Description:

This command allows set condition of the Service Request Enable register. Since bit 6 is not used, the maximum value is 191.

Parameters:

<DNPD> Service Request Enable register

Remarks:

Overlapped command

Example:

*SRE 2

*SRE? Response: 2

***ESR?**

Syntax:

*ESR?

Description:

This query returns the contents of the Event Status Register and clears the register.

Parameters:

<DNPD> Event Status Register

Remarks:

Overlapped command

Example:

*ESR? Response: 0

***ESE**

Syntax:

*ESE

*ESE?

Description:

This command programs the Event Status Enable register bits.

Parameters:

<DNPD> Event Status Enable register, Range 0 ... 255

Remarks:

Overlapped command

Example:

*ESE 2

*ESE? Response: 2

***CLS**

Syntax:

*CLS

Description:

This command clears all status data structures in the device i.e. Event Status Register, Status Byte Register except the MAV bit, Operation Status Register, Questionable Status Register. Also error queue is cleared. Output queue is unaffected.

Parameters:

None

Remarks:

Overlapped command

Example:

*CLS

6.9. SCPI Commands

This chapters describes all public SCPI commands in detailed form. The commands here are in alphabetic order.

:CALibration:RESistance:AMPLitude

Syntax:

:CALibration:RESistance:AMPLitude <DNPd>
:CALibration:RESistance:AMPLitude?

Description:

This command sets calibration value of particular internal resistance standard at output terminals including all parasitic resistances inside decade box.

Parameters:

<DNPd> Standard resistance value in Ohms. Ranges and default values varies in accordance to selected resistance etalon (see table “Calibration points M632”).

Remarks:

This command requires "Calibration" access

Overlapped command

Value is not affected by reset

Example:

CAL:RES:AMPL 1.944
CAL:RES:AMPL? Response: 1.944000E+00

:CALibration:RESistance:SElect

Syntax:

:CALibration:RESistance:SElect <DNPd>
:CALibration:RESistance:SElect?

Description:

This command enters calibration mode and selects internal resistance standard for calibration. Output terminals are automatically switched-on.

Parameters:

<DNPd> Range 1 ... Max. Resistance Count, one based index of resistance standard

Remarks:

This command requires "Calibration" access

Overlapped command

Example:

CAL:RES:SEL 1
CAL:RES:SEL? Response: 1

:CALibration:SECure:PASSword

Syntax:

:CALibration:SECure:PASSword <DNPd>

Description:

This command validates entered password and enables calibration access if verification is successful. Acces is invalidated after reset or if CAL:SEC:EXIT command is issued. Calibration password can be changed from decade system menu *SETUP->Calibration->Change password*.

Parameters:

<DNPd> Range 0 ... 4294967295 (default 0)

Remarks:

Overlapped command

Example:

CAL:SEC:PASS 0

:CALibration:SECure:EXIT

Syntax:

:CALibration:SECure:EXIT

Description:

This command exits calibration mode and access.

Parameters:

None

Remarks:

Overlapped command

Example:

CAL:SEC:EXIT

:DISPlay:ANNotation:CLOCk:DATE:FORMAT

Syntax:

:DISPlay:ANNotation:CLOCk:DATE:FORMAT <CPD>

:DISPlay:ANNotation:CLOCk:DATE:FORMAT?

Description:

This command sets format of date displayed on device screen.

Parameters:

<CPD> {MDYS|MDYA|DMYS|DMYO|DMYA|YMDS|YMDO} (default MDYS)
 ·MDYS M/D/Y format (M-month, D-day, Y-year)
 ·MDYA M-D-Y format
 ·DMYS D/M/Y format
 ·DMYO D.M.Y format
 ·DMYA D-M-Y format
 ·YMDS Y/M/D format
 ·YMDO Y.M.D format

Remarks:

Overlapped command

Value is not affected by reset

Example:

DISP:ANN:CLOC:DATE:FORM MDYS

DISP:ANN:CLOC:DATE:FORM? Response: MDYS

:DISPlay:ANNotation:CLOCk[:STATe]

Syntax:

:DISPlay:ANNotation:CLOCk[:STATe] <BOOL>

:DISPlay:ANNotation:CLOCk[:STATe]?

Description:

This command enables/disables showing actual time in title on device screen

Parameters:

<BOOL> {ON|OFF|1|0} (default 1)
 ·ON actual time is shown
 ·OFF actual time is hidden
 ·1 same as ON
 ·0 same as OFF

Remarks:

Overlapped command

Value is not affected by reset

Example:

DISP:ANN:CLOC ON

DISP:ANN:CLOC? Response: 1

:DISPlay:BRIGHtness

Syntax:

```
:DISPlay:BRIGHtness <DNPD>
:DISPlay:BRIGHtness?
```

Description:

This command sets brightness of device display.

Parameters:

| | |
|--------|--|
| <DNPD> | Range 0.0 ... 1.0 (default 1.0), 0.0 – Min, 1.0 – Max brightness |
|--------|--|

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
DISP:BRIG 1.0
DISP:BRIG? Response: 1.000000E+00
```

:DISPlay:LANGuage

Syntax:

```
:DISPlay:LANGuage <CPD>
:DISPlay:LANGuage?
```

Description:

This command sets language that is used on device display.

Parameters:

| | |
|----------|--|
| <CPD> | {ENGLish DEUTsch FRENch RUSSian SPANish CZECh} |
| | (default ENGL) |
| ·ENGLish | english version |
| ·DEUTsch | deutsch version |
| ·FRENch | french version |
| ·RUSSian | russian version |
| ·SPANish | spanish version |
| ·CZECh | czech version |

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
DISP:LANG ENGL
DISP:LANG? Response: ENGL
```

:OUTPut:SHORt

Syntax:

```
:OUTPut:SHORt <BOOL>
:OUTPut:SHORt?
```

Description:

This command turns on short function. “Short” is activated only if output terminals are switched on (see OUTP:STAT command).

Parameters:

| | |
|--------|-----------------------------------|
| <BOOL> | {ON OFF 1 0} (default 0) |
| ·ON | short is set if output is on |
| ·OFF | resistance is set if output is on |
| ·1 | same as ON |
| ·0 | same as OFF |

Remarks:

Overlapped command

Value is set to default after reset

Example:

```
OUTP:SHOR ON
```

OUTP ON
OUTP:SHOR? Response: 1

:OUTPut[:STATe]

Syntax:

:OUTPut[:STATe] <BOOL>
:OUTPut[:STATe]?

Description:

This command switches ON/OFF output terminals. This command operates in conjunction with OUTP:SHOR command:

| <i>OUTP:STAT</i> | <i>OUTP:SHOR</i> | <i>Output terminals</i> |
|------------------|------------------|-------------------------|
| OFF | OFF | Open |
| OFF | ON | Open |
| ON | OFF | Resistance |
| ON | ON | Short |

Table 4 OUTPut command structure

Parameters:

| | |
|--------|-----------------------------------|
| <BOOL> | {ON OFF 1 0} (default 0) |
| ·ON | output terminals are switched on |
| ·OFF | output terminals are switched off |
| ·1 | same as ON |
| ·0 | same as OFF |

Remarks:

Overlapped command
Value is set to default after reset

Example:

OUTP ON
OUTP? Response: 1

:OUTPut:SWITching

Syntax:

:OUTPut:SWITching <CPD>
:OUTPut:SWITching?

Description:

If output amplitude is changed and output terminals are already switched on, some glitches appear at output terminals. This setting allows selecting a method how new resistance at output terminals is achieved.

Parameters:

| | |
|---------|--|
| <CPD> | {FAST SMOoth OPEN SHORt} (default FAST) |
| ·FAST | new resistance is set as fast as possible |
| ·SMOoth | new resistance is set with minimal output changes |
| ·OPEN | open function is activated before new resistance is set |
| ·SHORt | short function is activated before new resistance is set |

Remarks:

Overlapped command
Value is not affected by reset

Example:

OUTP:SWIT FAST
OUTP:SWIT? Response: FAST

[:SOURce]:NICKel[:AMPLitude]

Syntax:

[:SOURce]:NICKel[:AMPLitude] <DNPD>[<UNIT>]
[:SOURce]:NICKel[:AMPLitude]?

Description:

This command sets temperature in Nickel mode. Node SOUR:NICK also selects “NICKEL” function if not already selected. If unit parameter is part of temperature, new unit is set.

Parameters:

| | |
|--------|--|
| <DNPD> | temperature at Nickel function. Default value is 100.0 °C. |
| <UNIT> | {CEL FAR K} |
| ·CEL | degrees of Celsius |
| ·FAR | degrees of Fahrenheit |
| ·K | Kelvin |

Remarks:

- Overlapped command
- Value is set to default after reset

Example:

NICK 100.0
NICK? Response: 1.000000E+02 CEL

[:SOURce]:NICKel:ZRESistance**Syntax:**

[:SOURce]:NICKel:ZRESistance <DNPD>[<UNIT>]
[:SOURce]:NICKel:ZRESistance?

Description:

This command sets resistance at 0 °C for Nickel function.

Parameters:

| | |
|--------|---|
| <DNPD> | Range 10.0 ... 20000.0 (default 100.0). |
| <UNIT> | {OHM} |
| ·OHM | |

Remarks:

- Overlapped command
- Value is not affected by reset

Example:

NICK:ZRES 100.0
NICK:ZRES? Response: 1.000000E+02 OHM

[:SOURce]:PLATinum[:AMPLitude]**Syntax:**

[:SOURce]:PLATinum[:AMPLitude] <DNPD>[<UNIT>]
[:SOURce]:PLATinum[:AMPLitude]?

Description:

This command sets temperature in Platinum mode. Node SOUR:PLAT also selects “PLATINUM” function if not already selected. If unit parameter is part of temperature, new unit is set.

Parameters:

| | |
|--------|--|
| <DNPD> | temperature at Platinum function. Default value is 100.0 °C. |
| <UNIT> | {CEL FAR K} |
| ·CEL | degrees of Celsius |
| ·FAR | degrees of Fahrenheit |
| ·K | Kelvin |

Remarks:

- Overlapped command
- Value is set to default after reset

Example:

PLAT 100.0
PLAT? Response: 1.000000E+02 CEL

[:SOURce]:PLATinum:COEFFcient

Syntax:

```
[:SOURce]:PLATinum:COEFFcient <DNPD>,<DNPD>,<DNPD>
[:SOURce]:PLATinum:COEFFcient?
```

Description:

This command allows to define Coefficients (A, B, C) used for “User” Platinum standard scale.

Parameters:

| | |
|--------|---|
| <DNPD> | Range 3.0e-3 ... 5.0e-3 (default 3.9083e-3), Coefficient A |
| <DNPD> | Range -7.0e-7 ... -5.0e-7 (default -5.775e-7), Coefficient B |
| <DNPD> | Range -5.0e-12 ... -3.0e-12 (default -4.18301e-12), Coefficient C |

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
PLAT:COEF 3.9083e-3,-5.775e-7,-4.18301e-12
```

```
PLAT:COEF? Response: 3.908300E-03,-5.775000E-07,-4.183010E-12
```

[:SOURce]:PLATinum:STANdard

Syntax:

```
[:SOURce]:PLATinum:STANdard <CPD>
[:SOURce]:PLATinum:STANdard?
```

Description:

This command selects Platinum temperature standard.

Parameters:

| | |
|---------|---|
| <CPD> | {PT385A PT385B PT3916 PT3926 USER} (default PT385A) |
| ·PT385A | Pt385 (68) standard |
| ·PT385B | Pt385 (90) standard |
| ·PT3916 | Pt3916 standard |
| ·PT3926 | Pt3926 standard |
| ·USER | User (see PLAT:COEF command) |

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
PLAT:STAN PT385A
```

```
PLAT:STAN? Response: PT385A
```

[:SOURce]:PLATinum:ZRESistance

Syntax:

```
[:SOURce]:PLATinum:ZRESistance <DNPD>[<UNIT>]
[:SOURce]:PLATinum:ZRESistance?
```

Description:

This command sets resistance at 0 °C for Platinum function.

Parameters:

| | |
|--------|---|
| <DNPD> | Range 10.0 ... 20000.0 (default 100.0). |
| <UNIT> | {OHM} |
| ·OHM | |

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
PLAT:ZRES 100.0
```

```
PLAT:ZRES? Response: 1.000000E+02 OHM
```

[:SOURce]:RESistance[:AMPLitude]

Syntax:

```
[:SOURce]:RESistance[:AMPLitude] <DNPD>[<UNIT>]
[:SOURce]:RESistance[:AMPLitude]?
```

Description:

This command sets amplitude in Resistance mode. Node SOUR:RES also selects “RESISTANCE” function if not already selected. Optionally unit can be enclosed.

Parameters:

| | |
|--------|------------------------------------|
| <DNPD> | Range 1.0 ... 1.2e6, default 100.0 |
| <UNIT> | {OHM} |
| ·OHM | |

Remarks:

Overlapped command
Value is set to default after reset

Example:

```
RES 100.0
RES? Response: 1.000000E+02 OHM
```

[:SOURce]:TIMing:PAPPend

Syntax:

```
[:SOURce]:TIMing:PAPPend <SPD>
```

Description:

This command appends new preset into timing function. The new appended preset has empty timing table and new records should be also appended (see TIM:PRES<index>:RAPP). The new preset has its own index and can be obtained by TIM:PCO command.

Parameters:

| | |
|-------|--|
| <SPD> | Quoted preset name. Upper alpha, lower alpha, digits and spaces are allowable. Maximum string size is 10 characters. |
|-------|--|

Remarks:

Overlapped command

Example:

```
TIM:PAPP "TIME2"
```

[:SOURce]:TIMing:PCOunt?

Syntax:

```
[:SOURce]:TIMing:PCOunt?
```

Description:

This command retrieves actual number of timing presets. This number represents maximum index used in preset commands.

Parameters:

| | |
|--------|---|
| <DNPD> | Integer value representing preset count |
|--------|---|

Remarks:

Overlapped command

Example:

```
TIM:PCO? Response: 1
```

[:SOURce]:TIMing:PRESet<IND_PRESET>:NAME

Syntax:

```
[:SOURce]:TIMing:PRESet<IND_PRESET>:NAME <SPD>
[:SOURce]:TIMing:PRESet<IND_PRESET>:NAME?
```

Description:

This command allows reading and changing preset name. The preset must exist before its name is changed or read.

Parameters:

<IND_PRESET> Range 1 ... Preset count (1 - if omitted)
 <SPD> Quoted preset name. Upper alpha, lower alpha, digits and spaces are allowable. Maximum string size is 10 characters.

Remarks:

Overlapped command

Example:

TIM:PRES2:NAME "TIME 1s"
 TIM:PRES2:NAME? Response: "TIME 1s"

[:SOURce]:TIMing:PRESet<IND_PRESET>:PDElete

Syntax:

[:SOURce]:TIMing:PRESet<IND_PRESET>:PDElete

Description:

This command allows deleting existing preset. The preset will be deleted including particular timing table.

Parameters:

<IND_PRESET> Range 1 ... Preset count (1 - if omitted)

Remarks:

Overlapped command

Example:

TIM:PRES1:PDEL

[:SOURce]:TIMing:PRESet<IND_PRESET>:RAPPend

Syntax:

[:SOURce]:TIMing:PRESet<IND_PRESET>:RAPPend <SPD>

Description:

This command appends new record at the end of timing table.

Parameters:

<IND_PRESET> Range 1 ... 255 (1 - if omitted)

<SPD> Quoted string representing amplitude. The amplitude consists of two float numeric fields separated by comma. The first one represents timing interval in seconds and the second one amplitude in Ohms.

Remarks:

Overlapped command

Example:

TIM:PRES1:RAPP "0.5,220.0"

[:SOURce]:TIMing:PRESet<IND_PRESET>:RCOunt?

Syntax:

[:SOURce]:TIMing:PRESet<IND_PRESET>:RCOunt?

Description:

This command returns actual number of records in timing table.

Parameters:

<IND_PRESET> Range 1 ... Preset count (1 - if omitted)

<DNPD> Integer value representing number of records

Remarks:

Overlapped command

Example:

TIM:PRES1:RCO? Response: 6

[:SOURce]:TIMing:PRESet<IND_PRESET>:ROW<IND_ROW>:AMPLitude

Syntax:

```
[:SOURce]:TIMing:PRESet<IND_PRESET>:ROW<IND_ROW>:AMPLitude <SPD>
[:SOURce]:TIMing:PRESet<IND_PRESET>:ROW<IND_ROW>:AMPLitude?
```

Description:

This command sets / retrieves selected row in timing table.

Parameters:

| | |
|--------------|--|
| <IND_PRESET> | Range 1 ... Preset count (1 - if omitted) |
| <IND_ROW> | Range 1 ... Row count (1 - if omitted) |
| <SPD> | Quoted string representing amplitude. The amplitude consists of two float numeric fields separated by comma. The first one represents timing interval in seconds and the second one amplitude in Ohms. |

Remarks:

Overlapped command

Example:

```
TIM:PRES2:ROW1:AMPL "0.5,220.0"
TIM:PRES2:ROW1:AMPL? Response: " 5.000000E-01,2.200000E+02"
```

[:SOURce]:TIMing:PRESet<IND_PRESET>:ROW<IND_ROW>:RDElete

Syntax:

```
[:SOURce]:TIMing:PRESet<IND_PRESET>:ROW<IND_ROW>:RDElete
```

Description:

This command deletes row from timing table.

Parameters:

| | |
|--------------|---|
| <IND_PRESET> | Range 1 ... Preset count (1 - if omitted) |
| <IND_ROW> | Range 1 ... Row count (1 - if omitted) |

Remarks:

Overlapped command

Example:

```
TIM:PRES2:ROW1:RDEL
```

[:SOURce]:TIMing:SElect

Syntax:

```
[:SOURce]:TIMing:SElect <DNPD>
[:SOURce]:TIMing:SElect?
```

Description:

This command selects timing preset. Selected preset is the preset that is shown on device display and has no effect on other SOUR:TIM commands.

Parameters:

| | |
|--------|---|
| <DNPD> | Range 1 ... Preset count (default 1), one based index of preset |
|--------|---|

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
TIM:SEL 1
```

```
TIM:SEL? Response: 1
```

[:SOURce]:UFUNction[:AMPLitude]

Syntax:

```
[:SOURce]:UFUNction[:AMPLitude] <DNPD>
[:SOURce]:UFUNction[:AMPLitude]?
```

Description:

This command sets amplitude in USER FUNCTION mode. Node SOUR:UFUN also selects “USER FUNCTION” function if not already selected.

Parameters:

<DNPD> Range depends on translation curve, default value is 1.0 or minimal value that can be set

Remarks:

Overlapped command
Value is set to default after reset

Example:

UFUN 1.0
UFUN? Response: 1.000000E+00

[:SOURce]:UFUNction:CURVe:SELect

Syntax:

[:SOURce]:UFUNction:CURVe:SELect <DNPD>
[:SOURce]:UFUNction:CURVe:SELect?

Description:

This command selects curve preset in User function mode.

Parameters:

<DNPD> Range 1 ... Curve preset count (default 1), one based index of preset

Remarks:

Overlapped command
Value is not affected by reset

Example:

UFUN:CURV:SEL 1
UFUN:CURV:SEL? Response: 1

[:SOURce]:UFUNction:CURVe:PAPPend

Syntax:

[:SOURce]:UFUNction:CURVe:PAPPend <SPD>

Description:

This command appends new curve preset into User function. The new appended preset has empty curve table and new records should be also appended (see UFUN:CURV:PRES<index>:RAPP). The new preset has its own index and can be obtained by UFUN:CURV:PCO command.

Parameters:

<SPD> Quoted curve preset name. Upper alpha, lower alpha, digits and spaces are allowable. Maximum string size is 10 characters.

Remarks:

Overlapped command

Example:

UFUN:CURV:PAPP "CURVE 2"

[:SOURce]:UFUNction:CURVe:PCOunt?

Syntax:

[:SOURce]:UFUNction:CURVe:PCOunt?

Description:

This command retrieves actual number of user function presets. This number represents maximum index used in preset commands.

Parameters:

<DNPD> Integer value representing number of preset count

Remarks:

Overlapped command

Example:

UFUN:CURV:PCO? Response: 1

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:NAME

Syntax:

```
[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:NAME <SPD>
[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:NAME?
```

Description:

This command allows reading and changing preset name. The preset must exist before its name is changed or read.

Parameters:

| | |
|--------------|--|
| <IND_PRESET> | Range 1 ... Curve preset count (1 - if omitted) |
| <SPD> | Quoted preset name. Upper alpha, lower alpha, digits and spaces are allowable. Maximum string size is 10 characters. |

Remarks:

Overlapped command

Example:

```
UFUN:CURV:PRES2:NAME "CURVE 2"
UFUN:CURV:PRES2:NAME? Response: "CURVE 2"
```

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:PDElete

Syntax:

```
[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:PDElete
```

Description:

This command allows deleting existing preset. The preset will be deleted including particular curve table.

Parameters:

| | |
|--------------|---|
| <IND_PRESET> | Range 1 ... Curve preset count (1 - if omitted) |
|--------------|---|

Remarks:

Overlapped command

Example:

```
UFUN:CURV:PRES1:PDEL
```

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:RAPPend

Syntax:

```
[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:RAPPend <SPD>
```

Description:

Parameters:

| | |
|--------------|--|
| <IND_PRESET> | Range 1 ... Curve preset count (1 - if omitted) |
| <SPD> | Quoted string representing amplitude. The amplitude consists of two float numeric fields separated by comma. The first one represents amplitude in "User Function" units and the second one amplitude in Ohms. |

Remarks:

Overlapped command

Example:

```
UFUN:CURV:PRES1:RAPP "10.6,220.0"
```

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:RCount?

Syntax:

```
[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:RCount?
```

Description:

This command returns actual number of records in curve table.

Parameters:

| | |
|--------------|---|
| <IND_PRESET> | Range 1 ... Curve preset count (1 - if omitted) |
| <DNPD> | Integer value representing number of records for particular curve table |

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES1:RCO? Response: 2

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:ROW<IND_ROW>:AMPLitude

Syntax:

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:ROW<IND_ROW>:AMPLitude <SPD>
 [:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:ROW<IND_ROW>:AMPLitude?

Description:

This command sets / retrieves selected row in curve table.

Parameters:

<IND_PRESET> Range 1 ... 255 (1 - if omitted)
 <IND_ROW> Range 1 ... 255 (1 - if omitted)
 <SPD> Quoted string representing amplitude. The amplitude consists of two float numeric fields separated by comma. The first one represents amplitude in “User Function” units and the second one amplitude in Ohms.

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES1:ROW1:AMPL "10.6,220.0"

UFUN:CURV:PRES1:ROW1:AMPL? Response: "1.060000E+01,2.200000E+2"

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:ROW<IND_ROW>:RDElete

Syntax:

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:ROW<IND_ROW>:RDElete

Description:

This command deletes row from curve table.

Parameters:

<IND_PRESET> Range 1 ... Curve preset count (1 - if omitted)
 <IND_ROW> Range 1 ... Row count (1 - if omitted)

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES1:ROW1:RDEL

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:UNIT

Syntax:

[:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:UNIT <SPD>
 [:SOURce]:UFUNction:CURVe:PRESet<IND_PRESET>:UNIT?

Description:

Parameters:

<IND_PRESET> Range 1 ... Curve presetcount (1 - if omitted)
 <SPD> Quoted user function unit. Upper alpha, lower alpha, digits and spaces are allowable. Maximum string size is 4 characters.

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES1:UNIT "N"

UFUN:CURV:PRES1:UNIT? Response: "N"

:STATus:OPERation:CONDition

Syntax:

:STATus:OPERation:CONDition?

Description:

This query returns the content of Operational Condition register. It is a decimal value which corresponds to the binary-weighted sum of all bits in the register. Register is not cleared after this query. The response to the query therefore represents an instantaneous 'Snapshot' of the register state, at the time that the query was accepted.

Parameters:

| | |
|--------|--------------------------------|
| <DNPd> | Operational Condition register |
|--------|--------------------------------|

Remarks:

Overlapped command

Example:

STAT:OPER:COND? Response: 2

:STATus:OPERation:ENABLE

Syntax:

:STATus:OPERation:ENABLE <DNPd>

:STATus:OPERation:ENABLE?

Description:

This command enables bits in the Operational Data Enable register. Selected bits are summarized at bit 7 (OSS) of the IEEE488.2 Status Byte register.

Parameters:

| | |
|--------|----------------------------------|
| <DNPd> | Operational Data Enable register |
|--------|----------------------------------|

Remarks:

Overlapped command

Example:

STAT:OPER:ENAB 2

STAT:OPER:ENAB? Response: 2

:STATus:OPERation[:EVENT]

Syntax:

:STATus:OPERation[:EVENT]?

Description:

This query returns the content of Operational Data Event register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Register is cleared after this query.

Parameters:

| | |
|--------|---------------------------------|
| <DNPd> | Operational Data Event register |
|--------|---------------------------------|

Remarks:

Overlapped command

Example:

STAT:OPER? Response: 0

:STATus:OPERation:NTRansition

Syntax:

:STATus:OPERation:NTRansition <DNPd>

:STATus:OPERation:NTRansition?

Description:

This command allows set Operation Negative Transition Register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Setting a bit in the negative transition filter shall cause a 1 to 0 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

Parameters:

<DNPD> Operation Negative Transition Register, Range 0... 32767
 Remarks:
 Overlapped command
 Example:
 STAT:OPER:NTR 2
 STAT:OPER:NTR? Response: 2

:STATus:OPERation:PTRansition

Syntax:
 :STATus:OPERation:PTRansition <DNPD>
 :STATus:OPERation:PTRansition?

Description:
 This command allows set Operation Positive Transition Register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Setting a bit in the positive transition filter shall cause a 0 to 1 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

Parameters:
 <DNPD> Operation Positive Transition Register, Range 0 ... 32767
 Remarks:
 Overlapped command
 Example:
 STAT:OPER:PTR 1.0
 STAT:OPER:PTR? Response: 1.000000E+00

:STATus:QUEstionable:CONDition

Syntax:
 :STATus:QUEstionable:CONDition?

Description:
 This query returns the content of Questionable Condition register. It is a decimal value which corresponds to the binary-weighted sum of all bits in the register. Register is not cleared after this query. The response to the query therefore represents an instantaneous 'Snapshot' of the register state, at the time that the query was accepted.

Parameters:
 <DNPD> Questionable Condition register
 Remarks:
 Overlapped command
 Example:
 STAT:QUES:COND? Response: 2

:STATus:QUEstionable:ENABLE

Syntax:
 :STATus:QUEstionable:ENABLE <DNPD>
 :STATus:QUEstionable:ENABLE?

Description:
 This command enables bits in the Questionable Data Enable register. Selected bits are summarized at bit 3 (QSS) of the IEEE488.2 Status Byte register.

Parameters:
 <DNPD> Questionable Data Enable register
 Remarks:
 Overlapped command
 Example:
 STAT:QUES:ENAB 2
 STAT:QUES:ENAB? Response: 2

:STATus:QUEStionable[:EVENT]

Syntax:

:STATus:QUEStionable[:EVENT]?

Description:

This query returns the content of Questionable Data Event register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Register is cleared after this query.

Parameters:

<DNPD> Questionable Data Event register

Remarks:

Overlapped command

Example:

STAT:QUES? Response: 0

:STATus:QUEStionable:NTRansition

Syntax:

:STATus:QUEStionable:NTRansition <DNPD>

:STATus:QUEStionable:NTRansition?

Description:

This command allows set Questionable Negative Transition Register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Setting a bit in the negative transition filter shall cause a 1 to 0 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

Parameters:

<DNPD> Questionable Negative Transition Register, Range 0... 32767

Remarks:

Overlapped command

Example:

STAT:QUES:NTR 2

STAT:QUES:NTR? Response: 2

:STATus:QUEStionable:PTRansition

Syntax:

:STATus:QUEStionable:PTRansition <DNPD>

:STATus:QUEStionable:PTRansition?

Description:

This command allows set Questionable Positive Transition Register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Setting a bit in the positive transition filter shall cause a 0 to 1 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

Parameters:

<DNPD> Questionable Positive Transition Register, Range 0... 32767

Remarks:

Overlapped command

Example:

STAT:QUES:PTR 2

STAT:QUES:PTR? Response: 2

:SYSTem:BEEPer:STATE

Syntax:

:SYSTem:BEEPer:STATE <BOOL>

:SYSTem:BEEPer:STATE?

Description:

This command sets state of device beeper.

Parameters:

| | |
|--------|----------------------------------|
| <BOOL> | {ON OFF 1 0} (default 1) |
| ·ON | device system beeper is enabled |
| ·OFF | device system beeper is disabled |
| ·1 | same as ON |
| ·0 | same as OFF |

Remarks:

Overlapped command

Value is not affected by reset

Example:

SYST:BEEP:STAT ON
SYST:BEEP:STAT? Response: 1

:SYSTem:BEEPer:VOLume

Syntax:

:SYSTem:BEEPer:VOLume <DNPD>
:SYSTem:BEEPer:VOLUME?

Description:

This command sets the system device beeper volume.

Parameters:

| | |
|--------|---|
| <DNPD> | Range 0.0 ... 1.0 (Max. volume) (default 0.2) |
|--------|---|

Remarks:

Overlapped command

Value is not affected by reset

Example:

SYST:BEEP:VOL 0.2
SYST:BEEP:VOL? Response: 2.000000E-01

:SYSTem:COMMUnicatE:BUS

Syntax:

:SYSTem:COMMUnicatE:BUS <CPD>
:SYSTem:COMMUnicatE:BUS?

Description:

This command selects communication interface.

Parameters:

| | |
|---------|-------------------------------------|
| <CPD> | {SERial GPIB USB LAN} (default SER) |
| ·SERial | RS232 interface |
| ·GPIB | GPIB interface |
| ·USB | USB interface |
| ·LAN | LAN interface |

Remarks:

Sequential command

Value is not affected by reset

Example:

SYST:COMM:BUS SER
SYST:COMM:BUS? Response: SER

:SYSTem:COMMUnicatE:GPIB:ADDResS

Syntax:

:SYSTem:COMMUnicatE:GPIB:ADDResS <DNPD>
:SYSTem:COMMUnicatE:GPIB:ADDResS?

Description:

This command allows set communication GPIB address

Parameters:

<DNPD> Range 1 ... 31 (default 2)

Remarks:

Overlapped command
Value is not affected by reset

Example:

SYST:COMM:GPIB:ADDR 2
SYST:COMM:GPIB:ADDR? Response: 2

:SYST:COMM:LAN:ADDRes

Syntax:

:SYST:COMM:LAN:ADDRes <CPD>
:SYST:COMM:LAN:ADDRes?

Description:

This command allows to change IP address if DHCP is switched off. Interface must be restarted to take effect (see SYST:COMM:REST command).

Parameters:

<CPD> Range 000.000.000.000 ... 255.255.255.255 (default 192.168.001.100)

Remarks:

Overlapped command
Value is not affected by reset

Example:

SYST:COMM:LAN:ADDR 192.168.001.100
SYST:COMM:LAN:ADDR? Response: 192.168.001.100

:SYST:COMM:LAN:MASK

Syntax:

:SYST:COMM:LAN:MASK <CPD>
:SYST:COMM:LAN:MASK?

Description:

This command allows to change subnet mask if DHCP is switched off. Interface must be restarted to take effect (see SYST:COMM:REST command).

Parameters:

<CPD> Range 000.000.000.000 ... 255.255.255.255 (default 255.255.255.000)

Remarks:

Overlapped command
Value is not affected by reset

Example:

SYST:COMM:LAN:MASK 255.255.255.000
SYST:COMM:LAN:MASK? Response: 255.255.255.000

:SYST:COMM:LAN:GATE

Syntax:

:SYST:COMM:LAN:GATE <CPD>
:SYST:COMM:LAN:GATE?

Description:

This command allows to change default gateway if DHCP is switched off. Interface must be restarted to take effect (see SYST:COMM:REST command).

Parameters:

<CPD> Range 000.000.000.000 ... 255.255.255.255 (default 255.255.255.255)

Remarks:

Overlapped command
Value is not affected by reset

Example:

```
SYST:COMM:LAN:GATE 255.255.255.255
SYST:COMM:LAN:GATE? Response: 255.255.255.255
```

:SYSTem:COMMunicate:LAN:PORT

Syntax:

```
:SYSTem:COMMunicate:LAN:PORT <DNPd>
:SYSTem:COMMunicate:LAN:PORT?
```

Description:

This command allows to change port number. Interface must be restarted to take effect (see SYST:COMM:REST command).

Parameters:

| | |
|--------|-------------------------------|
| <DNPd> | Range 0 ... 9999 (default 23) |
|--------|-------------------------------|

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
SYST:COMM:LAN:PORT 23
SYST:COMM:LAN:PORT? Response: 23
```

:SYSTem:COMMunicate:LAN:HOST

Syntax:

```
:SYSTem:COMMunicate:LAN:HOST <CPD>
:SYSTem:COMMunicate:LAN:HOST?
```

Description:

This command allows to change host name if DHCP is switched on. Interface must be restarted to take effect (see SYST:COMM:REST command).

Parameters:

| | |
|-------|---|
| <CPD> | Upper alpha, lower alpha, digits, underscores and spaces are allowable. Maximum string size is 14 characters. |
|-------|---|

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
SYST:COMM:LAN:HOST M632_SNXXXXXX
SYST:COMM:LAN:HOST? Response: M632_SNXXXXXX
```

:SYSTem:COMMunicate:LAN:DHCP

Syntax:

```
:SYSTem:COMMunicate:LAN:DHCP <BOOL>
:SYSTem:COMMunicate:LAN:DHCP?
```

Description:

This command allows switch On/Off DHCP.

Parameters:

| | |
|--------|--------------------------|
| <BOOL> | {ON OFF 1 0} (default 1) |
| .ON | DHCP is On |
| .OFF | DHCP is Off |
| .1 | same as ON |
| .0 | same as OFF |

Remarks:

Overlapped command

Value is not affected by reset

Example:

```
SYST:COMM:LAN:DHCP ON
SYST:COMM:LAN:DHCP? Response: 1
```

:SYSTem:COMMUnicatE:REStart

Syntax:

:SYSTem:COMMUnicatE:REStart

Description:

This command will restart communication interface. It will take several seconds. During this period device will not respond to any commands. Restart is needed for all LAN setting changes.

Parameters:

None

Remarks:

Overlapped command

Example:

SYST:COMM:REST

:SYSTem:COMMUnicatE:SERial:BAUD

Syntax:

:SYSTem:COMMUnicatE:SERial:BAUD <CPD>

:SYSTem:COMMUnicatE:SERial:BAUD?

Description:

This command allows changing RS232 transfer rate.

Parameters:

| | |
|---------|---|
| <CPD> | {1200 2400 4800 9600 19200 38400 57600 115200} (default 9600) |
| ·1200 | 1200 Bd |
| ·2400 | 2400 Bd |
| ·4800 | 4800 Bd |
| ·9600 | 9600 Bd |
| ·19200 | 19200 Bd |
| ·38400 | 38400 Bd |
| ·57600 | 57600 Bd |
| ·115200 | 115200 Bd |

Remarks:

Overlapped command

Value is not affected by reset

Example:

SYST:COMM:SER:BAUD 9600

SYST:COMM:SER:BAUD? Response: 9600

:SYSTem:DATE

Syntax:

:SYSTem:DATE <DNPD>,<DNPD>,<DNPD>

:SYSTem:DATE?

Description:

This command allows to change system device date.

Parameters:

| | |
|--------|---------------------------|
| <DNPD> | Year, Range 2000 ... 2063 |
| <DNPD> | Month, Range 1 ... 12 |
| <DNPD> | Day, Range 1 ... 31 |

Remarks:

Overlapped command

Example:

SYST:DATE 2012,12,31

SYST:DATE? Response: 2012,12,31

:SYSTem:ERRor[:NEXT]?

Syntax:

:SYSTem:ERRor[:NEXT]?

Description:

This command reads SCPI error (maximum 32) that occurred at first. If number of SCPI errors exceed 32, error -350 “Queue overflow” is returned. For all available error codes and messages see “SCPI Error codes” table. Error queue is cleared by reading all errors or by issuing *CLS command.

Parameters:

<DNPD>

Error code

<SPD>

Quoted error message

Remarks:

Overlapped command

Example:

SYST:ERR? Response: -300,”Device error”

:SYSTem:KEY

Syntax:

:SYSTem:KEY <DNPD>

:SYSTem:KEY?

Description:

This command allows send key code to the device the same way the user can press keys on front panel. Query returns last pressed key.

| Key | Code |
|---------------|------|
| KEY_0 | 12 |
| KEY_1 | 11 |
| KEY_2 | 15 |
| KEY_3 | 19 |
| KEY_4 | 10 |
| KEY_5 | 14 |
| KEY_6 | 18 |
| KEY_7 | 9 |
| KEY_8 | 13 |
| KEY_9 | 17 |
| KEY_SELECT | 25 |
| KEY_ENTER | 24 |
| KEY_CANCEL | 23 |
| KEY_UP | 2 |
| KEY_DOWN | 1 |
| KEY_LEFT | 3 |
| KEY_RIGHT | 4 |
| KEY_EXPONENT | 21 |
| KEY_BACKSPACE | 22 |
| KEY_POINT | 16 |
| KEY_USER_1 | 5 |
| KEY_USER_2 | 6 |
| KEY_USER_3 | 7 |
| KEY_USER_4 | 8 |
| KEY_SIGN | 20 |
| KEY_OPER | 26 |
| KEY_SHORT | 27 |

Table 5 Keyboard codes

Parameters:

<DNPD> Key code. For particular key codes see table above.

Remarks:

Overlapped command

Example:

SYST:KEY 12

SYST:KEY? Response: 12

:SYSTem:LOCal

Syntax:

:SYSTem:LOCal

Description:

This command places device in the LOCAL mode and unlocks all keys on front panel of the device. The Command is valid only for RS232, LAN and USB interfaces. The device will not respond to commands in LOCAL mode.

Parameters:

None

Remarks:

Overlapped command

Example:

SYST:LOC

:SYSTem:PRESet

Syntax:

:SYSTem:PRESet

Description:

This command will preset all device settings. These settings are the same as the RESET ones.

Parameters:

None

Remarks:

Overlapped command

Example:

SYST:PRES

:SYSTem:REMRote

Syntax:

:SYSTem:REMRote

Description:

This command places device in the REMOTE mode and locks all keys but LOCAL key. The Command is valid only for RS232, LAN and USB interfaces. The device will not respond to any other command until is in REMOTE mode.

Parameters:

None

Remarks:

Overlapped command

Example:

SYST:REM

:SYSTem:RWLock

Syntax:

:SYSTem:RWLock

Description:

This command places device in the REMOTE mode and locks all keys including LOCAL key. The Command is valid only for RS232, LAN, USB interfaces. The device will not respond to any other command until is in REMOTE mode.

Parameters:

None

Remarks:

Overlapped command

Example:

SYST:RWL

:SYSTem:TIME

Syntax:

:SYSTem:TIME <DNPD>,<DNPD>,<DNPD>

:SYSTem:TIME?

Description:

This commands allows set system device time (RTC).

Parameters:

| | |
|--------|-------------------------|
| <DNPD> | Hours, Range 0 ... 23 |
| <DNPD> | Minutes, Range 0 ... 59 |
| <DNPD> | Seconds, Range 0 ... 59 |

Remarks:

Overlapped command

Example:

SYST:TIME 10,45,15

SYST:TIME? Response: 10,45,15

:SYSTem:VERSion?

Syntax:

:SYSTem:VERSion?

Description:

This query retrieves version of implemented SCPI language

Parameters:

| | |
|-------|-----------------------|
| <CPD> | SCPI language version |
|-------|-----------------------|

Remarks:

Overlapped command

Example:

SYST:VERS? Response: 1999.0

:UNIT:TEMPerature

Syntax:

:UNIT:TEMPerature <CPD>

:UNIT:TEMPerature?

Description:

This function allows to set unit for all temperature functions (Platinum, Nickel).

Parameters:

| | |
|-------|---------------------------|
| <CPD> | {CEL FAR K} (default CEL) |
| .CEL | degrees of Celsius |
| .FAR | degrees of Fahrenheit |
| .K | Kelvin |

Remarks:

Overlapped command

Value is not affected by reset

Example:

UNIT:TEMP CEL

UNIT:TEMP? Response: CEL

6.10. SCPI Error codes

Decade box distinguishes following SCPI error codes. These codes are reported on device display screen or can be read by SYST:ERR? Command.

| Error | Message |
|-------|--|
| -100 | "Command error" |
| -101 | "Invalid character" |
| -102 | "Syntax error" |
| -103 | "Invalid separator" |
| -104 | "Data type error" |
| -105 | "GET not allowed" |
| -108 | "Parameter not allowed" |
| -109 | "Missing parameter" |
| -112 | "Program mnemonic too long" |
| -113 | "Undefined header" |
| -114 | "Header suffix out of range" |
| -120 | "Numeric data error" |
| -121 | "Invalid character in number" |
| -130 | "Suffix error" |
| -141 | "Invalid character data" |
| -144 | "Character data too long" |
| -151 | "Invalid string data" |
| -161 | "Invalid block data" |
| -203 | "Command protected" |
| -220 | "Parameter error" |
| -222 | "Data out of range" |
| -283 | "Illegal variable name" |
| -350 | "Queue overflow" |
| -400 | "Query error" |
| -410 | "Query INTERRUPTED" |
| -420 | "Query UNTERMINATED" |
| -430 | "Query DEADLOCKED" |
| -440 | "Query UNTERMINATED after indefinite response" |
| 514 | "Command not allowed with GPIB" |

Table 6 SCPI error codes

6.11. Compatible Commands

Decade box also responds to “Old style” command syntax to provide compatibility with previous decade box models.

Value setting / reading

A (?) <DNPD>

The command sets resistance value (resistance function), temperature value (temperature sensor simulating function) or “User function” value (if User function is selected).

<DNPD>

It represents resistance value in Ohm or simulated temperature in selected temperature unit or “user defined units” (if User function is selected). When temperature parameter is used, both negative and positive values are acceptable. For resistance parameter positive value only is acceptable. Limit values are shown in chapter “Technical data”.

In case of control, the simulator confirms correct setting with string „Ok<cr><lf>”.

In case of query, M632 returns set resistance/temperature/user_function value in the same format as it is on the display (number of decimal places). For example value -120 °C is returned as -120.000<cr><lf>. Positive numbers are sent without polarity sign.

Example :

Command „A123.564 <cr>” sets temperature 123.564 °C if simulator is in temperature simulation function, 123.564 Ω if simulator is in resistance function and 123.564 X if decade is in User function (X – represents user defined unit).

If query „A?<cr>” is sent, simulator returns response in format „123.564<cr><lf>”.

Decade function setting

F <CPD> { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | S | O }

Following function can be set:

- 0 resistance mode
- 1 Pt385 (68) temperature sensor simulation
- 2 Pt385 (90) temperature sensor simulation
- 3 Pt3916 temperature sensor simulation
- 4 Ni temperature sensor simulation
- 5 User platinum temperature sensor simulation
- 6 Pt3926 temperature sensor simulation
- 7 User function simulation
- S Short
- O Open

M632 confirms execution with string „Ok<cr><lf>”.

Example :

„F1<cr>” sets Pt100 sensor simulation.

I/D (device identification)***IDN?**

Response contains name of manufacturer, model type number, serial number, firmware version

Example :

If query „*IDN?<cr>” is sent, decade returns response:

„MEATEST,M632,622351,1.2 <cr><lf>“.

R0 setting / reading**R (?) <DNPD>**

Command sets resistance value R0 at temperature 0 °C. Set value R0 is valid for all types of simulated temperature sensors.

<DNPD>

It represents resistance value R0 in Ω . Limits are shown in chapter Technical data. M632 confirms execution with string „Ok<cr><lf>”. In case of query M632 returns set value in Ω .

Example :

„R100<cr>” sets value R0 to 100 Ω (Pt100, Ni100).

After query „R?<cr>” decade returns string „100<cr><lf>”.

Temperature unit setting**U <CPD> { 0 | 1 | 2 }**

Command sets used temperature unit.

- 0 sets degree Celsius °C
- 1 sets degree Fahrenheit °F
- 2 sets Kelvin unit K

M632 confirms execution with string „Ok<cr><lf>”.

Example :

„U0<cr>” sets °C as temperature unit.

Status reading**V?**

M632 returns device status in form „FxUx<cr><lf>”. On positions of signs „x“ there are values corresponding to the actual status of decade.

Example :

After query „V?<cr>” decade returns for example string „F2U0<cr><lf>”, which means Pt (90), °C actual setting.

Correctly executed command is confirmed with string "Ok<cr><lf>". When correct query is received M632 returns response in above described format. All commands must contain sign <cr> or <lf> at the end. Both small and large letters can be used.

6.12. Demo program

A simple operating program DecadeAssistant is supplied with the decade in order to provide easy operation of the instrument from the computer, and to check the RS-232 line (IEEE488 bus) of the instrument. The installation CD ROM contains a program (for MS WINDOWS only), you can communicate with the instrument through standard serial line (IEEE488) with. For example, you can set value or function on the decade. For IEEE488 connection this DecadeAssistant requires properly configured National Instruments IEEE488 card.

Download on www.meatest.com.

7. Maintenance

This chapter explains how to perform the routine maintenance to keep your device in optimal operating condition. The tasks covered in this chapter include the following:

- Fuse replacing
- External surface cleaning

7.1. Fuse replacing

The instrument includes a fuse located in the mains connector at the rear panel. Replace the fuse as follows:

- Switch off the decade box
- Remove the end of power cord from the mains connector at the rear panel.
- Insert the blade of a flat screwdriver into the opening cut in the mains voltage selector and pull out the fuse holder.
- Remove the fuse and replace it with new fuse of the same rating.

7.2. External surface cleaning

To keep the device looking like new, clean the case and front panel keys using a soft cloth slightly dampened with either water or a non-abrasive mild cleaning solution that is not harmful to plastics.

8. Module 19" (version M632-Vxx1x)

Decade can be ordered as 19" module for easy assembling into a 19" rack. Module height is 3HE.



Figure 28 Module 19" rack, front panel

9. Technical data

| | | |
|---|---|---|
| Resistance range | : | 1 Ω ... 1 MΩ SHORT, OPEN terminals |
| Pt sensor temperature simulation | : | -200.000 °C ... 850.000 °C (-328 °F ... 1562 °F) |
| Ni sensor temperature simulation | : | -60.000 °C ... 300.000 °C (-76 °F ... 572 °F) |
| Type of temperature sensors | : | Pt10 ... Pt20000, Ni10 ... Ni20000 |
| Resolution | : | from 0.01 mΩ |
| Pt temperature standards | : | IEC 751 (1,3850 for IPTS68) (A=3.90802e-3, B=-5.80195e-7, C=-4.2735e-12) IEC 751 (1,3851 for ITS90) (A=3.9083e-3, B=-5.775e-7, C=-4.18301e-12) 1,3916 (A=3.9692e-3, B=-5.8495e-7, C=-4.2325e-12) 1,3926 (A=3.9848e-3, B=-5.870e-7, C=-4.0e-12) |
| Ni temperature standards | : | DIN 43760 (6180) (A=5.485e-3, B=6.65e-6, C=2.805e-11, D=-2e-17) |
| Maximal dissipation power | : | 0.25 W |
| Maximal current | : | 0.5 A |
| Maximal voltage | : | 200 Vpk |
| Reaction time * | : | 6 ms |
| Terminals | : | instrument terminals diameter 4mm, gold plated |
| Interface | : | RS232 (optionally IEEE488, USB, Ethernet) |
| Power supply | : | 115/230 Vac, 45...65 Hz |
| Maximal power consumption | : | 15 VA |
| Reference temperature | : | +20 °C ... +26 °C |
| Working temperature | : | +5 °C ... +40 °C |
| Storing temperature | : | -10 °C ... +50 °C |
| Housing | : | metal sheet |
| Dimensions | : | W 390 mm, H 128 mm, D 310 mm |
| Weight | : | 5.2 kg |

Isolation resistance between output terminals and housing : > 2 GΩ (at 500V DC)

* Reaction time means time interval between setting up value from front panel or receiving command from remote control bus and settling set-up value on output terminals. Value is valid for FAST switching mode.

Notes:

Only data shown with tolerance or with band of limits are tested. All other values have informative character.

Accuracy

Specified accuracy is valid after 10 minutes warm up in temperature range $23 \pm 3^\circ\text{C}$. Uncertainties include long-term stability, temperature coefficient, linearity, load and line regulation and traceability of factory to National calibration standards. Accuracies assigned in % are related to the set value. Specified accuracy is one-year accuracy.

M632 Resistance accuracy

| Range / Resolution | Accuracy |
|--|------------------------|
| 1.000 00 Ω - 2.000 00 Ω | 0.002 % + 2 m Ω |
| 2.000 1 Ω - 20.000 0 Ω | |
| 20.001 Ω - 200.000 Ω | |
| 200.01 Ω - 2000.00 Ω | 0.003 % |
| 2.000 1 k Ω - 20.000 0 k Ω | |
| 20.001 k Ω - 200.000 k Ω | |
| 200.01 k Ω - 1200.00 k Ω | 0.005 % |

Table 7 M632 Resistance accuracy

M632 Pt simulation accuracy

| Temperature | Accuracy Pt10 ... Pt99 | Accuracy Pt100 ... Pt20000 |
|------------------------------------|------------------------|----------------------------|
| -200.000...0.000 $^\circ\text{C}$ | 0.05 $^\circ\text{C}$ | 0.01 $^\circ\text{C}$ |
| 0.001...200.000 $^\circ\text{C}$ | 0.06 $^\circ\text{C}$ | 0.015 $^\circ\text{C}$ |
| 200.001...500.000 $^\circ\text{C}$ | 0.08 $^\circ\text{C}$ | 0.03 $^\circ\text{C}$ |
| 500.001...850.000 $^\circ\text{C}$ | 0.1 $^\circ\text{C}$ | 0.04 $^\circ\text{C}$ |

Table 8 M632 Pt simulation accuracy

M632 Ni simulation accuracy

| Temperature | Accuracy Ni10 ... Ni99 | Accuracy Ni100 ... Ni20000 |
|------------------------------------|------------------------|----------------------------|
| -60.000...300.000 $^\circ\text{C}$ | 0.05 $^\circ\text{C}$ | 0.01 $^\circ\text{C}$ |

Table 9 M632 Ni simulation accuracy

M632 Frequency response

| R | AC/DC difference | | |
|----------------|------------------|--------|--------|
| | 100 Hz | 1 kHz | 10 kHz |
| 1 Ω | 0.01 % | 0.02 % | 0.20 % |
| 10 Ω | 0.01 % | 0.01 % | 0.04 % |
| 100 Ω | 0.01 % | 0.05 % | 0.50 % |
| 1 k Ω | 0.05 % | 0.50 % | 5.00 % |
| 10 k Ω | 0.50 % | 5.00 % | |
| 100 k Ω | 5.00 % | | |

Table 10 M632 Frequency response

Temperature coefficient

Temperature coefficient outside of the reference temperature range is 10 % of the stated specification per °C (for example 2x specification for 36°C).

Short and Open simulation

When function Short is selected, output resistance is lower than 60 mΩ. Maximal allowed current is 500 mA.

When function Open is selected, output resistance is higher than 1 GΩ. Maximal allowed voltage is 200 Vpk.

Note:

Resistance values in range 1 Ω - 1.2 MΩ are calibrated absolutely. Resistance value is not defined against SHORT position. Short and Open positions are intended for functional checking of tested instrument only.

Ordering information – options

Bus

| | |
|-------------------|----------------------------|
| M632-V1xxx | - RS232 |
| M632-V2xxx | - RS232, LAN, USB, IEEE488 |

Housing

| | |
|-------------------|-------------------|
| M632-Vxx0x | - table version |
| M632-Vxx1x | - module 19“, 3HE |

Example of order:

M632-V2010

- Precision Resistance Decade 1Ω - 1.2MΩ, RS232, LAN, USB, IEEE488, 19“ rack

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